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OCTOBER 15, 1941

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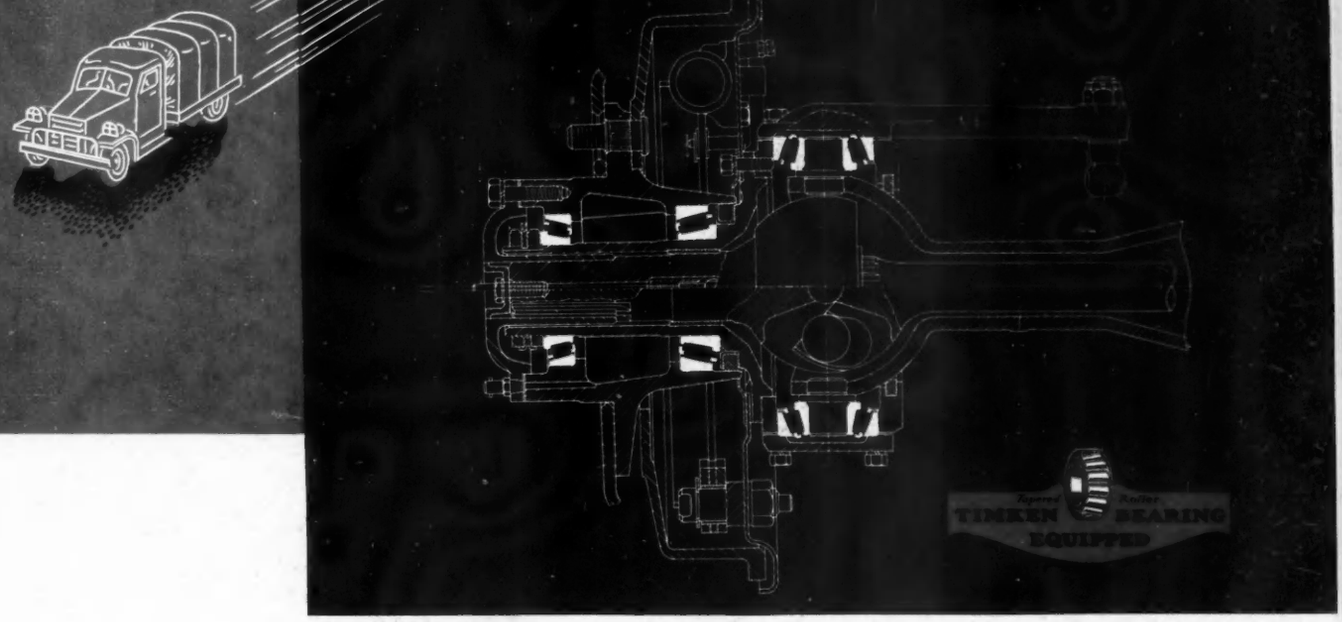

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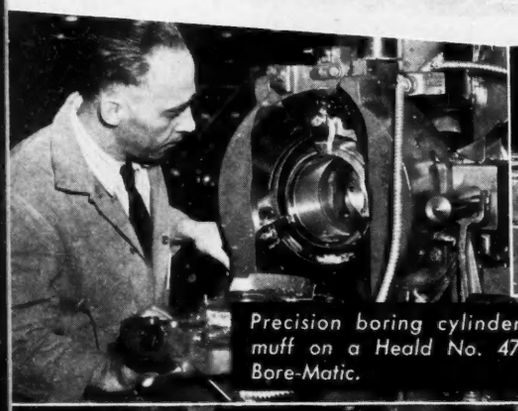
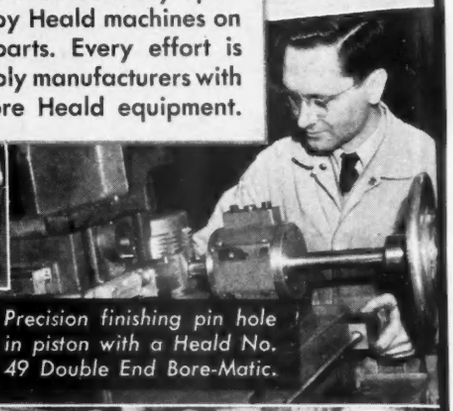
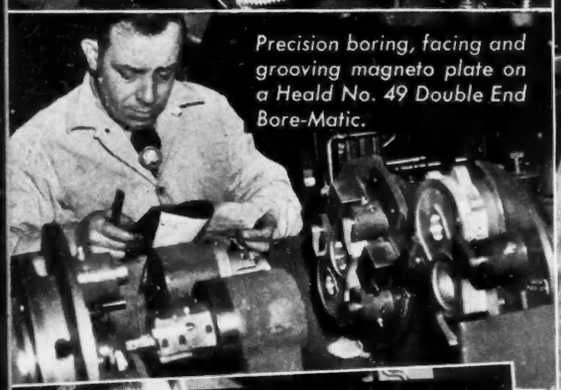


Precision boring cylinder muff on a Heald No. 47 Bore-Matic.

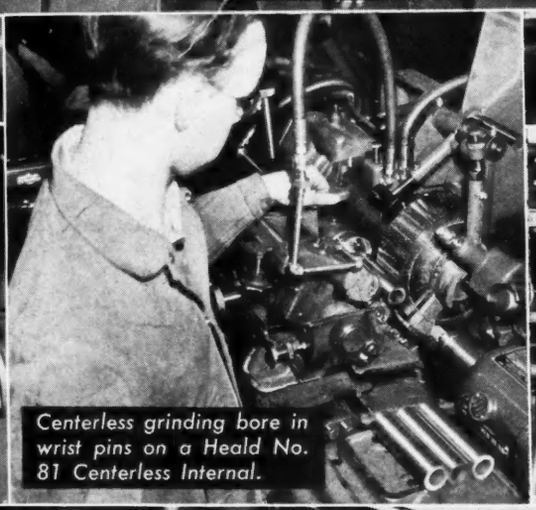
Precision boring airplane engine spark plugs on a Heald No. 49 Bore-Matic.



Precision finishing pin hole in piston with a Heald No. 49 Double End Bore-Matic.



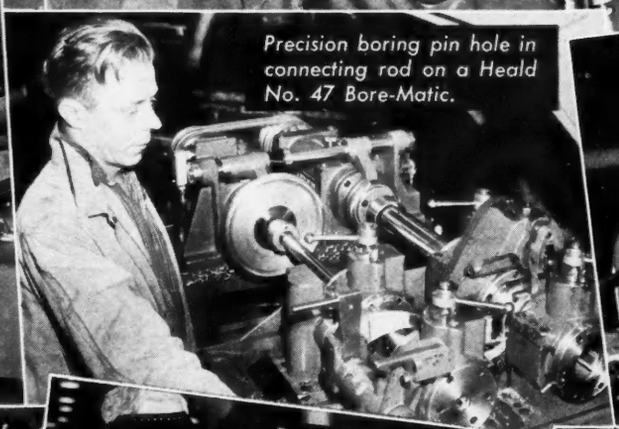
Precision boring, facing and grooving magneto plate on a Heald No. 49 Double End Bore-Matic.



Centerless grinding bore in wrist pins on a Heald No. 81 Centerless Internal.

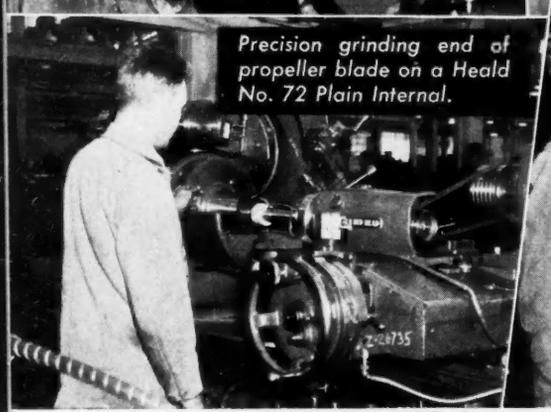
Precision grinding cam surface in propeller cam on a Heald Special No. 72 Plain Internal.

Precision grinding taper seat in propeller hub on a No. 74 Heald Internal.



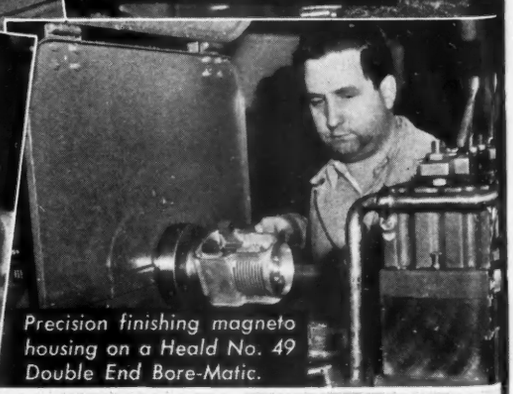
Precision boring pin hole in connecting rod on a Heald No. 47 Bore-Matic.

Precision turning and facing reduction gear carrier pins on a Heald No. 47 Bore-Matic.



Precision grinding end of propeller blade on a Heald No. 72 Plain Internal.

Precision boring bronze wrist pin hole in master rod on a Heald No. 48 Bore-Matic.



Precision finishing magneto housing on a Heald No. 49 Double End Bore-Matic.

THE HEALD MACHINE COMPANY

WORCESTER, MASS., U. S. A.

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The AUTOMOBILE

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OFFICES

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IN THIS ISSUE . . .

AUTOMOTIVE INDUSTRIES

Reg. U. S. Pat. Off.

Volume 85 October 15, 1941 Number 8

Engineering Societies Organize Defense Board

An Engineers' Defense Board, consisting of engineers and technologists from several national engineering societies, has been formed to deal with technical problems on shortages, substitutions, conservation, raw materials, production and reclamation in the nation-wide adjustment under the impact of the defense effort. An initial membership of five representatives each has been appointed by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society of Automotive Engineers, and the American Institute of Chemical Engineers. Representatives of the SAE comprise C. L. McCuen, vice-president, General Motors Corp., executive committee representative; Rex B. Beisel, chief engineer, Vought-Sikorsky Aircraft Corp.; C. E. Frudden, Allis-Chalmers Co.; Arthur Nutt, vice-president, Wright Aeronautical Corp.; James C. Zeder, chief engineer, Chrysler Corp.

A MESSAGE

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The United States is today, as it has always been, the best investment in the world. This is an opportunity for each citizen to buy a share in America.

High Quality and Long Life Built into the Car of 1942 **11**

Many factors have entered into the design and production of the new models. In this article Joseph Geschelin has opened the shutters and looked the whole situation over analyzing the many things that have influenced the changes in the new models and their production.

Aviation at Top Speed **20**

In the all-out efforts that are being made by the several countries in these days of strife many new developments have been introduced to produce the most effective bombers and fighters. A. T. Colwell shows us a picture not only of things that have been done but things to be done in this and the more belligerent countries.

Aircraft Engine Superchargers **22**

The development of the supercharger for the modern aircraft engine and how it operates is the subject of Henry L. Brownback's article; it is not only instructive but interesting.

The Metal Congress and Exposition **34**

Many will travel to Philadelphia during the week of Oct. 20 to attend this twenty-third annual meeting. More important this year than ever before this article gives an account of what to look for and what can be learned.

Making the Borg & Beck Fluid Coupling **36**

Much attention has been centered upon this late development and here are additional data on it. This time how it is produced at the plant in Chicago.

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AUTOMOTIVE INDUSTRIES

Published on the 1st and 15th of the month

Vol. 85, No. 8
October 15, 1941

High Quality and Long Life Built into the Car of 1942

Alternate Materials Effectively Employed. Extensive Styling Changes Enhance Eye-Appeal. Transmissions Highspot Mechanical Developments.

By Joseph Geschelin

So far as the buyers of motor cars are concerned, they may thank the metallurgists of the automotive and allied industries for the fact that the 1942 cars will continue to uphold the tradition of fine quality and long life in the new crop of cars.

Programs of metallurgical research now under way point to improvements in the future. Many valuable structural materials—ferrous and non-ferrous—will have ample opportunity to prove their worth. And it is quite conceivable that some of the materials formerly employed may have a difficult time in displacing them. Moreover, numerous techniques that had but little opportunity to demonstrate their worth under normal conditions and circumstances now have the all clear signal. Some of these new processes may well be the leaders in the metallurgy of the future.

The major activity among the builders of passenger cars in preparation for this new model year arose from the need for replacing those structural materials which were made unavailable for civilian use. Indeed many of the mechanical changes and much of the change in manufacturing procedures has been brought about by the shift to entirely different materials.

Despite the forebodings of the uninitiated, the industry has found it possible to present fresh styling treatment in the new cars. This may be credited to the advanced planning prevalent in the industry, making it possible to produce the dies for new sheet metal before the defense program dipped into the tool and die establishments. As a matter of fact, the 1942 cars present as much of a styling change as in any other year. This is a logical development when you consider that every manufacturer had to abandon the use of zinc alloy die castings for the grilles and other decorative treatment, substituting stampings wherever die castings had been employed. The compulsory use of steel stamped grilles gave designers an opportunity of wider expression in sheet metal treatment, provided the logical excuse for major changes in front end sheet metal.

Even a cursory examination of the new cars will reveal the marked changes in eye appeal. In General Motors, the influence of Harley Earl's "Car of the Future" is felt through-

STIMULATED by the challenge of the national emergency, the metallurgists of the industry have again shown themselves to be scientists and research workers of great stature, worthy of exceptionally high place in engineering circles. For the first time in this generation, the designers and manufacturers of motor cars have had to rely to a large extent not upon the familiar materials of construction nor upon materials of proven economy; the industry has had to seek out and adapt the best that was available in sufficient quantities of materials not ear-marked for defense purposes.

The fact that the excellent job that has been so successfully done was accomplished, apparently, in a matter of months, is due in large measure to the amazing wealth of knowledge accumulated through past effort and technical experience by the metallurgists. False prophets have sought to label the present situation as a blessing in disguise and a key to future promise on the assumption that the emergency was a critical spur to metallurgical research and development. But what is really true is that because the industry has constantly searched and researched, studied and tested, in its never interrupted effort to find better structural materials, it has developed a vast fund of pertinent knowledge and experience and is now in a position to elect alternatives that may be acceptable, albeit, in some cases, not so economical from the production man's point of view.

The cars of 1942 will uphold the American tradition of fine quality and long life in its motor cars.—J. G.

out the lines, but particularly in the case of Cadillac and Buick. The new Buick convertible with its car-length sweep of front fender line is a striking example of pioneering in radical channels.

Clipper styling, introduced by Packard early in 1941, dominates the styling of the new Packard line.

Changes in styling are found in all makes—in the entire line of Chrysler Corporation cars, Hudson, Studebaker, Nash, and Willys. However, since eye appeal can be but poorly expressed in words, we leave you with the physical evidence of the cars themselves.

The most noteworthy mechanical advancement for the new model year is found in the fast shifting picture of transmission arrangements. The pioneering stage of automaticity in gear shifting has been successfully negotiated. The public has had ample opportunity to express its opinions as to the efforts of the industry along this line. That the verdict of the public is one of wholehearted approval is quite evident in the sales record of Olds and Chrysler and Cadillac.

In General Motors, both Olds and Cadillac continue the Hydra-Matic transmission which has made such a remarkable record during the past few years. Packard offers the Electromatic Drive—the combination of a vacuum-operated, electrically controlled clutch and electrically controlled overdrive unit — as optional equipment on every car in the line. Chrysler has had phenomenal success with its Fluid Drive and combinations of Fluid Drive with four-speed transmissions, and is continuing this option on all cars except Plymouth.

The latest development in this field is the entry of Borg & Beck as a producer of Fluid Couplings. This unit has been adopted by Studebaker and another company is expected to announce it as optional equipment after the first of the year. It has been incorporated in extremely interesting arrangements of control elements in each case. The control system on the Studebaker cars makes it possible to eliminate the clutch pedal wherever the fluid coupling is installed. The arrangement is used in combination with automatic overdrive.

Ford also is offering an optional transmission arrangement with automatic shifting features. This will be available on the Mercury and Lincoln cars. It is called the Liquimatic Drive, and comprises a fluid coupling in conjunction with a 3-speed transmission and automatic overdrive. All of the shifts are made automatically at the operator's option by means of the accelerator pedal.

Hudson has a unique installation, called the Drive-Master. This includes automatic clutch control, and automatic shift from second to high and back to second, or complete hand control. In addition, the device will accommodate an automatic overdrive, if desired. By a suitable electric control system, gear shifting can be obtained in one of three ways—pressing the button marked "Vac," brings in the Vacumotive Drive circuit, providing automatic clutch operation with conventional manual gear shifting; pressing the button marked "HDM" brings in the entire Drive-Master hook-up so that the car may be driven with power clutch operation and automatic shifting of gears from the second speed Pick-Up to High and back, with the gear shift lever set in the high position; pressing the "Off" button cuts out both Vacumotive Drive and Drive-Master, permitting conventional clutch and gear shift operation.

As will be noted by referring to the individual car descriptions, there are many mechanical changes of a minor nature, such as are normally found in a new model. However, apart from the increasing trend to automaticity in gear shifting arrangement, the major

mechanical changes have been brought about by the shifting of materials specifications.

Perhaps the greatest influence of the latter is found in the engines. A few engine builders, notably Ford, Chevrolet, and Pontiac have been unaffected by the pinch on aluminum for pistons. Others like Plymouth, Studebaker, Dodge, De Soto, Buick, Olds, Nash, Willys, have found it necessary to shift to ferrous alloys of one type or another. Cadillac and Packard are continuing the use of aluminum and will stay with aluminum so long as they can get sufficient secondary metal, although Packard has tooling ready for the Six and Eight, for cast iron, if it is necessary to shift over. Doubtless, Cadillac is prepared for the same eventuality. Buick has changed to cast iron on the small engine but hopes to continue with aluminum on the large engine. Generally speaking, the six-cylinder cars in Chrysler Corp., representing the largest volume producers, have shifted to ferrous pistons. The eights will continue with aluminum.

The shift to ferrous pistons with their

increased weight and less favorable heat conductivity has been accompanied by varying effects upon the performance and set-up of standard engines. In the case of Packard, the change indicates an improvement for the better, with an increase in engine output and an increase in engine speed if need be. The main physical change made in Packard engines to take care of the increased loading is the adoption of the heavy-duty thin high-lead-babbitt bearings for the mains and rods. In the case of Plymouth, where the output of the engine has been stepped up to 95 hp., the shift to cast iron was accompanied by the introduction of heavier connecting rods, heavy-duty engine bearings, and a heavier and stiffer crankshaft. At Studebaker the shift was made so late in the season that there was little opportunity to effect changes in engine components. However, it was found that simply by reducing the top speed, with some depreciation in performance, no mechanical changes of any kind were needed and the life of the bearings remained the same as before. At Buick the shift to cast iron on the small engine caused a small loss in power due to the inability to hold the dome contour with the same precision as in the aluminum permanent mold piston casting. At Olds the principal change due to the adoption of ferrous pistons is the introduction of the Moraine bearing for the mains and rods.

With the introduction of cast iron pistons, Buick has adopted a procedure that should be of wide interest to the industry. Naturally, it was desirable to retain the same size and form of connecting rod so as to continue the use of the available forging dies. However, the material formerly used did not have adequate physical properties to handle the added loading. Accordingly, the material specification was changed to SAE X1345 steel to increase the physical properties. In addition, the rods now are shot blasted all over to increase resistance to fatigue.

Another important development at Buick is the adoption of what they have termed, "Oil Cushion Finish" for the crankpins and journals. This is a special type of surface finish produced by grinding with a free-cutting wheel, followed by machine lapping with a 240-grit cloth. The process is designed to produce a fine surface free from minute imperfections, combined with pits or depressions under the bearing surface. These pits are controlled as to size and dispersion. Measured with the Profilometer, this surface has a reading between 30 and 50 micro-inches (rms.). It is claimed that this type of finish greatly prolongs the life of con rod bearings under adverse service conditions.

The biggest story this year, however, is in the metals. It is a dramatic story of alternate materials, of hectic changes to meet new priorities, of substitutions for substitutions to the end point in the ability of the industry to continue the program. The fact of the matter is that if the materials situation could be frozen as it exists at the moment, the industry can continue right through the model year with a highly acceptable product. However, the limit already has been reached in a few places where critical materials cannot be dispensed with, where alternatives will not do.

Fortunately in these critical places the actual amounts of "verboten" ingredients are measured in ounces per car. Everyone hopes that OPM will permit these small amounts to be released. If not, a shortage in exhaust valve steel or a shortage in copper and brass for radiators may well stop car production.

Materials Substitutions Program

The following is a generalized discussion of the set-up of materials for the start of the model run, touching upon other alternatives which may be dictated by the shifting materials picture, and noting examples of specific practice wherever such information has been made available.

It may be observed at this point the newly adopted steel specifications developed by the American Iron and Steel Institute (AISI specifications) now prevail and are used by buyers of steel. These specifications, approved by OPM, trend to a simplification of varieties of steels, eliminating many SAE numbers in the process. AISI specifications include standard numbers for Amola steels.

Aluminum

Aluminum has been employed sparingly in motor car design, fortunately for the industry, the principal use being for engine pistons and for hydraulic brake system pistons. In addition, Buick has used aluminum castings for the rocker arm shaft bracket to compensate for expansion in the valve gearing.

The engine piston situation already has been touched upon. Cast iron pistons weigh from 50 to 85 per cent more than aluminum, have about half the thermal conductivity of aluminum, and a coefficient of expansion about half that of aluminum. Piston clearances will have to be closer with cast iron, which is a desirable change and piston pins must be stepped up in diameter to compensate for increased loading.

In replacing aluminum, we have the good grades of cast iron, the light weight steel alloys used by Ford and Chevrolet, and a pearlitic malleable iron which has been adopted by Olds. This material, trade-marked ARMA steel, has higher physical properties than cast iron and, consequently, can be cast in thinner sections with a marked saving in weight.

With the shift to ferrous pistons, the industry is fortunate in having available a number of different materials and processes for coating pistons, to facilitate break-in and to prevent scuffing and scoring of tightly fitted cylinder assemblies. Among these is the Parco Lubrite process—a non-metallic oil-absorptive chemical coating of iron and manganese phosphates; the Ferrox iron-oxide coating, and others. The Parco Lubrite process, described in AUTOMOTIVE INDUSTRIES, July 1, 1941, has been most widely adopted for the coating of pistons and is employed for the coating of other engine parts such as camshafts, piston rings, fan pulleys, valve tappets, etc.

This type of coating, moreover, eliminates the use of tin for this purpose, thereby writing off the utilization of a material on the critical list.

So far as aluminum is concerned, perhaps the one item that gave the most worry was the hydraulic brake system piston. Up to now this small item was made of virgin aluminum by the extrusion process. Aluminum was employed principally because it is a good bearing material, has good physical properties, is resistant to corrosion, and requires the very minimum of machining due to accurate sizing in the extrusion process.

That problem has been solved satisfactorily in a number of ways. For example, Olds and Studebaker are using cast iron cylinders instead of aluminum. Others are experimenting with a steel stamping coated with tin or powdered iron metallurgy which produces parts made accurately to size.

Zinc Die Castings

The major weight of zinc alloy in automobile construction has passed out of the picture quite completely. Die cast radiator grilles have been replaced with assemblies of steel stampings, either chromium plated or with a facing of stainless steel molding. Instrument panel grilles have been replaced with steel stampings or with plastics of the available grades.

Ornamentation such as radiator ornaments, fender trim strips, lamp bezels, license plate brackets, etc., has been supplanted by steel stampings or plastics or antimonial lead die castings of the new formulas containing arsenic. The change has not been painful, save for the usual reluctance to a major shift, while eye appeal has been quite unaffected.

On the other hand, there are a few places where zinc die castings are of a decidedly functional character. Here they play a vital role in cost reduction due to the production of precision molded castings which require very little machining. Perhaps the most vital die casting is the carburetor body. This is an exceedingly intricate part and most difficult to duplicate in cast iron, due to the tremendous number of machining operations that would be required if the part were to be machined in its entirety. Moreover, it is questionable whether the degree of precision demanded for the proper functioning of the modern carburetor can be achieved by machining methods.

It is hoped that the small amount of zinc required for hardware and for carburetor bodies and for fuel pump bodies will be made available by the powers that be, in the interest of cost reduction and correct functioning of motor cars; also in the interest of fuel economy which is paramount in the emergency.

Nevertheless, the carburetor manufacturers are not leaving the situation open to fortuitous circumstance. With characteristic zeal they have been experimenting with cast iron in preparation for any emergency. So well have they wrought that one passenger car builder already is fitting his six cylinder standard line with cast iron carburetors. However, the carburetor for an Eight is a different story. Up to the present writing, the carburetor manufacturer has been unable to produce a cast iron body which can be made satisfactorily and at any reasonable cost. Again we join with those who hope that this situation will not be sadly complicated for the lack of a relatively modest amount of zinc.

Tin

Although tin is not yet on the priorities list, it is a strategic metal primarily because all of it is imported

and transported over long stretches of hostile waters. Tin is used in engine bearings, in bronze bushings, in radiator solder, body solder, in tin foil for condensers, in terne plate for gasoline tanks and for mufflers.

The volume of tin for engine bearings already has been greatly decreased by the general adoption of extremely thin babbitt bearings which have improved fatigue life. In addition, the percentage of tin used in bearing alloys has been reduced by the adoption of high-lead babbitts containing only about 3 or 4 per cent tin, as in the case of the Moraine bearing which is used by Buick for the mains and by Olds for the mains and rods. On the spun-in rod bearings, Buick has reduced tin content from 10 per cent down to 6 per cent, with an addition of 10 per cent of antimony.

Radiator solder contains 90 per cent lead and 10 per cent tin. If no tin were available, an excellent solder could be produced with 95 per cent lead and 5 per cent silver. Incidentally, this country owns so much silver that silver solders could be more widely exploited from now on without danger of running through the stock pile.

Copper, Nickel, Chromium, for plating

Bright plating is not functional and may be dispensed with in an emergency. As a matter of fact, recent experimental work indicates that pleasing and even strikingly decorative effects have been achieved by art and color people with the use of color.

Nevertheless, designers would like to continue with bright plating so long as the ingredients are available. A great deal of work has been done in the interest of conserving critical materials for this purpose. Current practice has consisted of first depositing a layer of copper about 0.0003 in. thick on the base metal, gollowed by a layer of 0.0007 in. of nickel, then a flash of chromium. The most recent work shows that this procedure may be modified radically without sacrificing durability. This can be done by increasing the layer of copper to about 0.0008 in., reducing the nickel layer to about 0.0002 in. For interior hardware items, it might be possible to eliminate nickel, using only a heavy coating of copper with a flash of chromium.

Corrosion Resistant Steels for valves, for trim

Let us first dispose of the item of the so-called stainless steels for body moldings and trim. Quite a number of the 1942 cars have employed such materials generously in decorative effects on their show models. Whether this practice will continue in production under present restrictions is open to question. On the other hand if no material is available for this purpose, it is expected to be a rather simple matter to shift to plating or color, albeit this change in procedure during the course of production might work considerable hardship.

When it comes to valve steels, the consensus of metallurgists and engine designers is that metallurgical science at this stage of development simply has no substitute for high chromium and nickel alloys. True, it is possible to make certain minimum compromises in steel practice. But there is a definite limit to what may be done. If the minimum requirements cannot be met, then the high performance engine will be so limited in its output and in useful life as to make it questionable whether engines should be built at all.

Exhaust valve steels currently in use contain as much as 24 per cent chromium and 5 per cent nickel but the alloy specifications vary quite widely. For example, a popular valve material contains 21 per cent chromium and 12 per cent nickel. In General Motors, the best compromise has been found in the material which has been successfully used by Buick for a

number of years, namely an alloy containing about 18 per cent chromium and from 1½-2 per cent nickel. This material already has been adopted by Olds.

It is felt that the Buick alloy represents about the minimum specification for an acceptable valve steel with the accustomed durability. Here, too, there is fervent hope that OPM will see its way clear to make the relatively small amounts of chromium and nickel available for exhaust valve materials.

When it comes to intake valves, the problem is not so serious. Indications are that Amola steels will be popular for this purpose. In fact, Studebaker has joined Chrysler units in adopting this material for its intake valve requirements.

Deep Drawing Steel

There is considerable apprehension as to whether the ultra-ductile sheet steel which has given such excellent service in the making of the modern front fenders will continue to be available. The basis for worry arises from the fact that all deep drawing steels of the "stabi-

(*Turn to page* 50, *please*)

AVIATION INDUSTRIES

Survey of Warplane Development Reveals Rapid Strides Being Made by America, Britain and Germany in "All-Out" Effort to Produce the Best Fighters, Bombers and Other Military Aircraft.

Aviation at Top S

By A. T. COLWELL*

OUR PRESENT designs of fighters and bombers are the finest for performance and quality to be found in the world today. Our engines have proven to be the most dependable. The only test of war material is war, and our designers quickly turned from commercial to war craft and applied the things this war has demonstrated. Well over 300 m.p.h. for bombers and 400 m.p.h. for fighters (plus a climbing rate of one mile per minute) seems to be the accepted standard. Both armor and armament are increasing. Machine guns proved inadequate against bombers, hence the use of 20-mm. and 37-mm. cannon. Armor has increased likewise.

The British have learned from the war and have new fighting equipment. The new Rolls-Royce Griffin motor develops 1700 hp., the Napier Sabre 2000 hp., and the Rolls-Royce Vulture 2000 hp. The Hawker Tornado has the Napier Sabre. The Beaufighter carries four 20-mm. cannon of the Oerlikon type under the nose, firing 550 rounds per min., and six machine guns, firing 1200 rounds per min. This is Britain's finest night fighter, equipped with two Hercules 18-cylinder, air-cooled motors; two-speed supercharger; hydromatic, full-feathering propeller; top speed 330 m.p.h.; range 1500 miles at 200 m.p.h.; ceiling 28,900 ft. It was designed for heavy armament and long range.

The Germans are not using as many new planes. The Messerschmitt 109F is a faster version of the Me-109. The Me-110 has been a mean fighting ship with its 2200 hp. The Me-109F has less armament, using two machine guns and one cannon, flies at 380 m.p.h. with a reputed ceiling of 38,000 ft. It is designed to attack high-flying bombers. A Messerschmitt 109F was recently shot down in England and is reported to be a good plane. (See Sept. 15 issue of AUTOMOTIVE INDUSTRIES for a description of the Me-109F.

The four-motor Focke-Wulf Kurier is used by the Germans for long-range convoy attack. The new Heinkel 177 is claimed to have a top speed of 300 m.p.h. plus, and to carry over 20 tons of bombs. Its range is stated as 7000 miles.

A new fighter is the Focke-Wulf 198-DB 603 pusher motor; 1375 hp.; four 20-mm. cannon and two 15-mm. machine guns; heavy armor; reputed 400 m.p.h plus.

The British have developed some long-range bombers, but are depending upon two great American ships—the Boeing B-17E and the Consolidated B-24. The B-17E is a 20-ton bomber, has four Cyclone engines, its range 3000 miles at 330 m.p.h., 4-ton bomb load, ceiling 30,000 ft. plus. By the end

* Abstract of the aviation section of a paper prepared recently by Mr. Colwell, Vice-President of Thompson Products, Inc., and President of S.A.E.

Underwood & Underwood Photo

Lockheed bombers are being used effectively by the R.A.F. for patrolling the seas to protect British possessions and shipping.

Speed

Curtiss - Wright Corp. will build, this cargo-transport warplane at its St. Louis and Buffalo plants for the Army Air Force, which recently approved it for production. Now designated the Curtiss C-46, it originally was designed as an airliner to transport 36 passengers, crew of five and 5000 lb. of baggage at speeds over 210 m.p.h. at high altitudes. Power is supplied by two Wright Cyclone 1700 hp. engines.

of 1942 it is expected that these ships will be produced at 500 per month. Ford, Consolidated, Boeing, Douglas and Vega will build them.

Medium bombers are getting into production—the Martin B-26, Douglas DB-7, Lockheed-Hudson and Vega Ventura and North America B-25. The B-26 is the fastest bomber of its type in the world. It takes 24,000 man-hours to build one of them, using about 23,000 lb. of aluminum.

The Douglas B-19 bomber was started five years ago to test the practicability of this type of plane. It weighs 140,000 lb., range 7500 miles with a bomb load of 36,000 lb. or 125 fully equipped soldiers. It is 112 ft. long, wing spread 212 ft., and will cruise at 210 m.p.h. It is 35 ft. to the pilot's seat, has a telephone system of 24 stations, four 2-way radios, and carries a crew of 10. If this type plane is useful, it has been proved that they can be manufactured. This plane has 8000 hp., the greatest ever put in a plane.

A new bomber design, released by Glenn Martin, has the following characteristics: It weighs 250,000 lb. and will carry 80,000 lb. of bombs 3700 miles, or 40,000 lb. 7000 miles at 300 m.p.h.

Our new fighter planes are beginning to get production. They came first because England initially needed defense not offense. Republic's Thunderbolt (YP 47), with turbo supercharger, 2000 hp. Pratt & Whitney engine, 400 m.p.h. top speed and 35,000 ft. ceiling, carries several machine guns and cannon.

Lockheed P-38 interceptor—two Allison engines with turbo-superchargers, 400 m.p.h., .30- and .50-caliber machine guns and two cannon. This is the fastest military plane in the world today.

Curtiss P-40 D, one Allison, 380 m.p.h., six .50-caliber machine guns. The P-46 fighter, experimental, is a greatly improved plane.

North American P-51 (Apache or Mustang), new type wing, 400 m.p.h. plus, Allison engine.

The new laboratory of the National Advisory Committee for Aeronautics at Cleveland will be the finest in the world. It will have the world's largest wind tunnel, built for simulating high-altitude and low-temperature operation. Wind at 300 m.p.h. at sea level, and 490 m.p.h. at substratosphere density, will be produced. The aim is to develop more power for less weight; the powerplant of a pursuit ship is about 35 per cent of its total weight. Fuel economy will be studied. A specific fuel reduction from .51 to .50 would allow the Atlantic Clipper to carry four more passengers. Fuels and supercharging will be studied, realizing that most of the energy in fuel is wasted. Cowling and cooling research has produced much of value at Langley Field, and at present a study is being made of boundary layer effect, the .002 of vacuum near the leading edge of the wing. Also, frontal area, engine position, and streamlining are vital research problems.

Pratt & Whitney, Wright Aeronautical Corp. and Allison have done a magnificent job in producing high-powered aircraft motors. Both P & W and Wright have engines producing over 2000 dependable horsepower. These engines have made possible for the Navy to fly the world's fastest Navy fighter, and the Army a bomber faster than most pursuit planes. Allison has recently increased power to 1350 hp., and is giving great speed to some of the newer fighters. The engine essentially controls the fighter's armament, the bomber's load and range, and the patroller's range. Engines are produced at nearly 5000 per month now,

(*Turn to page* 33, *please*)

Aircraft Engine S

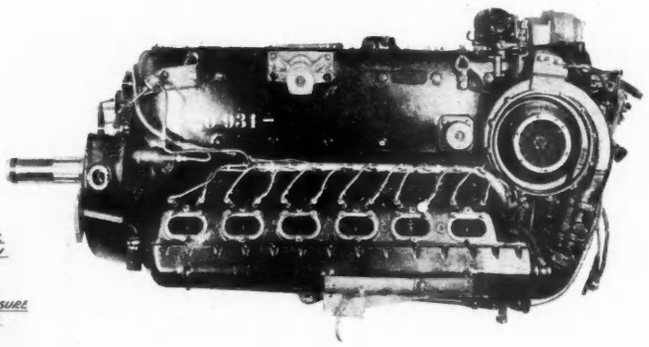
By HENRY L. BROWNBACK

THE SUPERCHARGER made the modern airplane possible. During the first World War some experiments were begun to supercharge fighting-plane engines so as to increase radically the ceiling of these machines, as well as to increase their speed at ordinary altitudes.

In 1917 two distinct types were being experimented with, both comprising a high-speed, centrifugal-type blower, which was belt-driven in one installation and driven by an exhaust turbine in the other. Both were designed and built by Rateau in France, and fitted to French fighting planes. Both gave trouble, one from constant belt failure and the other from failure of the turbine element and of the engine exhaust valves, due to back pressure.

American interest in superchargers began during World War I and took tangible form in 1922, when the Engineering Division of the Army Air Service at McCook Field had the General Electric Co. build a turbine-driven supercharger unit, which was fitted to the Packard 1237 Vee-type water-cooled engine. Tests run with this installation were very successful, and another type was built in 1923 for the Liberty aircraft engine. Flight tests showed that full engine power could be maintained up to 30,000 ft. altitude, which was most interesting from the military point of view, as planes of the type used in the test formerly had ceilings of from 18,000 to 20,000 ft.

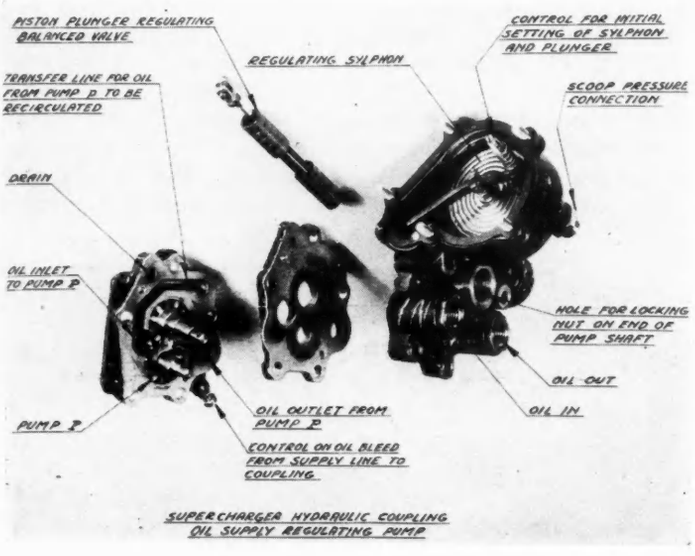
While both of these were successful operating units and one of them enabled a Lepere plane fitted with a Liberty engine to establish a new world's altitude record, the turbine units gave trouble, because the high operating temperatures greatly reduced the strength of the blade material, and blade failures, therefore, were frequent. Another reason why the turbine type had to yield ground to the mechanically driven type was that the former induced exhaust-valve failure. It must be understood that the engines with which these early experiments were made had large valves with small-diameter, solid stems, and that no special provisions were made to get the heat away from

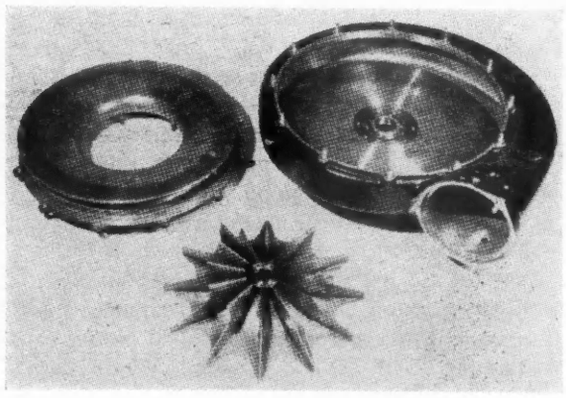


(Top right) The supercharger is mounted on the side at the rear. This view shows the compressor casing and impeller.

(Below right) The disassembled compressor unit of the supercharger. The impeller is 10¼ in. in diameter. Originally an aluminum alloy forging, it is smoothly machined all over and finished by the anodizing process.

(Below) A fluid coupling is incorporated in the supercharger drive. These are the drive assembly parts and housing which contains both primary and secondary pumps supplying oil to the fluid coupling.

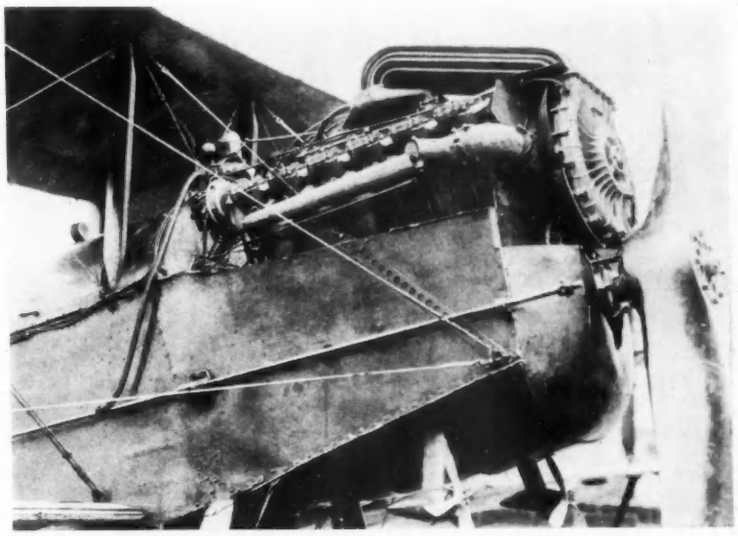

PISTON PLUNGER REGULATING BALANCED VALVE
REGULATING SYLPHON
CONTROL FOR INITIAL SETTING OF SYLPHON AND PLUNGER
TRANSFER LINE FOR OIL FROM PUMP D TO BE RECIRCULATED
SCOOP PRESSURE CONNECTION
DRAIN
OIL INLET TO PUMP P
HOLE FOR LOCKING NUT ON END OF PUMP SHAFT
OIL OUT
OIL IN
OIL OUTLET FROM PUMP P
PUMP P
CONTROL ON OIL BLEED FROM SUPPLY LINE TO COUPLING
SUPERCHARGER HYDRAULIC COUPLING OIL SUPPLY REGULATING PUMP



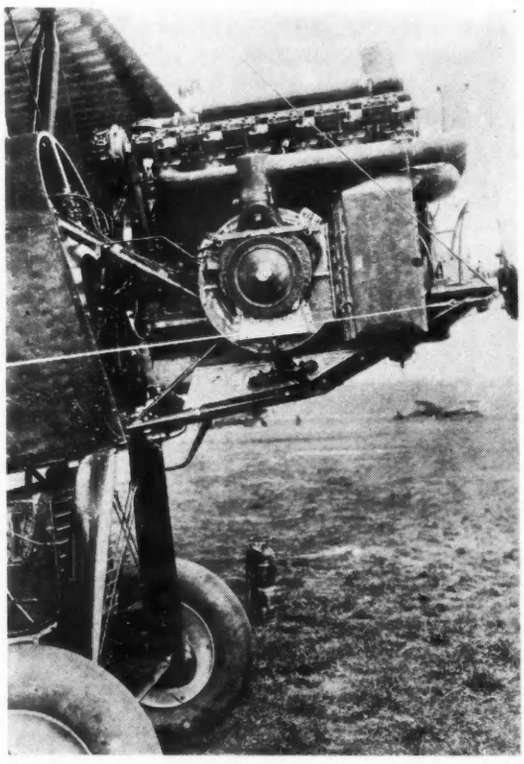
Superchargers—

Various Types, Their Development and Operation

(Right) The first installation of the turbo-supercharger was at the front of a Liberty-12 engine in 1918. So successful was the development of this machine that it was responsible during the early Twenties for a number of world records. This installation was known as the nose-type.



(Below) Due to its advantages, the side-type replaced the nose-type turbo-supercharger. In 1924 at McCook Field, a world's altitude record was set by a U.S. Air Corps TP-1 plane equipped with a Liberty-12 engine and a side-type turbo-supercharger. This installation had an overhung turbine wheel. The air cooler is located in front of the compressor casing.



the heads and into the valve guides, with the result that valve pitting and burning was common with open exhaust stacks, and certain when the back-pressure of the turbine increased the valve temperature.

Before going further it may be well to explain the general lay-out of the exhaust-driven supercharger, which remains substantially unchanged in today's perfected installations. The engine exhaust is led into a header which leads to the supercharger turbine element, and this exhaust header or collector is fitted with a gate valve leading to the atmosphere, so that opening the valve will permit the engine to exhaust into the atmosphere, while closing it gradually will build up pressure in the header and drive the turbine, which attains its maximum speed and power when the valve is entirely closed.

The turbine element of the supercharger is connected directly to the blower element, which latter takes air from the atmosphere and forces it through a cooling element or "intercooler" to the carburetor air intake, bleeder tubes maintaining supercharger pressure in the carburetor float chamber (if float-feed carburetors are used) and sometimes in the fuel tanks, so that the entire fuel system is in pressure balance.

This, of course, differs from the installation of gear-driven superchargers as used on most airplane engines today, where the carburetors are fitted to the intake side of the supercharger, which then pumps combustible mixture instead of air.

It may be of interest at this point to consider the other types of supercharger used in aircraft work, and the conditions of service of the various types, to arrive at a better understanding of their qualities and their limitations.

As far as the blower element is concerned, the centrifugal type has been the most successful, as it has

large volumetric capacity for a given weight and comprises a minimum number of parts. The first mechanically driven superchargers had the impeller driven at a fixed ratio to the engine crankshaft through a train of gears and a slip clutch designed to protect the impeller and gear train against inertia forces resulting from sudden changes in engine speed.

Another type has a single impeller driven through a multiple-speed transmission, which latter usually consists of a gear train with a simple clutch element for one speed and a planetary overdrive for the higher speed. To the best of my knowledge, this two-speed supercharger was invented by Charles Waseige in France and first applied to the Farman engine.

Inspecting impellers for General Electric superchargers. In driving air into the engine's intake system, they revolve at speeds up to 20,000 r.p.m.

The third type is a multi-stage blower in which two or more blower units are arranged in series, and the air can be either tapped off at the end of any stage or the pressure can be controlled by means of a gate valve at the carburetor inlet.

The Mercedes Benz engine which the Germans are using extensively in this war employs a fluid coupling in the drive for its multiple speed supercharger, which is not unlike fluid drives currently employed in motor cars. However, it has one radical difference in that the ratio of speed between the driven and driving units is governed by the amount of oil fed to these units and this is arranged for by a pump, the output of which is controlled by an atmospheric valve so that the supercharger output varies directly with the drop in atmospheric pressure as the plane gains altitude. The last type, of course, is the turbine-driven blower, with which we began this article.

Before we go into the advantages or disadvantages of any particular type, let us consider just what a supercharger must do. An aircraft engine of 1500 hp. consumes about five tons of air per hour, and this must be fed to the cylinders at normal atmospheric pressure at all altitudes where the airplane will be used. To do this it takes 196 hp. to drive the supercharger for a 1200-hp. engine and 326 hp. for a 2000-hp. engine, and this latter power seems to be that desired for military aircraft.

If the air is heated before entering the supercharger, the power requirements increase appreciably; for an increase of 50 deg. Fahr. in the inlet temperature of the air the horsepowers consumed by the supercharger increase by 24 and 40 in the two cases considered, respectively.

The foregoing gives, I believe, a fairly clear picture of some of the factors which must govern the choice of a supercharger type. The single or fixed-speed, gear-driven supercharger fitted right into the design of the radial air-cooled engines makes an ideal installation. The first installations functioned primarily as rotary distributors and not as true superchargers, insuring even distribution, which had been a major problem with radial engines. Here the carburetor was mounted on the blower inlet and the gaseous mixture was fed to the engine through the blower. This simplified the installation, gave very good fuel distribution, and was very light, but it had several major disadvantages, first, in order to prevent the carburetor from icing, it was necessary to preheat the incoming air. While the partial vaporization of the fuel absorbed some of this heat, the temperature of the mixture was raised by the heat of compression in the blower. This lowered the density of the mixture and made the engine more prone to detonate, because of the high inlet temperature.

Further disadvantages are that any leakage of air into the supercharger upsets the mixture ratio, and any ice which forms in the carburetor and gets into the engine will strike the blades of the impeller, which is turning at very high speed.

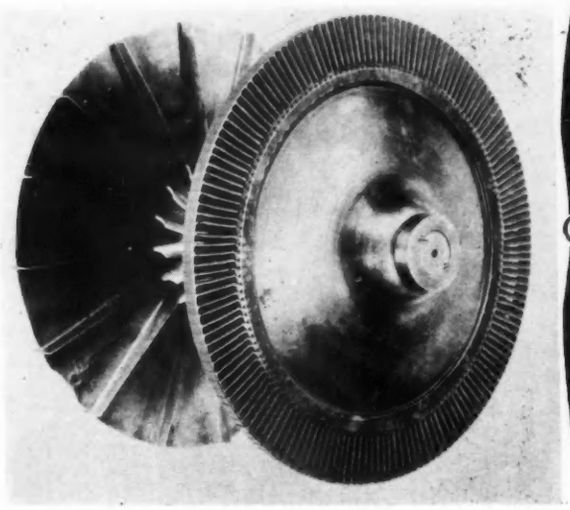
Certain gear-driven superchargers have two-speed gears. To build a friction clutch and a planetary overdrive which will fit into the very limited space avail-

able, transmit up to 400 hp. and weigh not more than a small fraction of a pound per horsepower, involves some very difficult problems. However, the two-speed solution offers many advantages over the multi-stage compressor, from a weight and bulk standpoint, and from the efficiency standpoint as well.

On "vee" type engines with more or less "wind up" in the crankshaft, the problem of keeping the supercharger gear train functioning becomes troublesome, and it is on engines of this type that we see most of the turbine type of supercharger development. The turbine type is bulkier than the gear-driven types, because of the bulk of the collector, the turbine (which must be adequately cooled), and the intercooler for the air. These considerations led to the early adoption of "side mounting," the turbine shaft being set at 90 deg. to the crankshaft, the supercharger being next to the engine and the turbine overhung. This solved the turbine-cooling problem and made a more compact installation than the nose type of machine first used.

One advantage of the type of supercharger which delivers air to the carburetor is that a backfire in the inlet system does not shock the supercharger, as it does in the types where the flame completely envelops the impeller, which has been submerged in gasoline vapor. On the turbine type the intercooler must be strong enough to withstand the pressures created by backfires and must be so designed that there will be no appreciable pressure drop in the air passing through it, as this would require the use of extra power to maintain the necessary pressure at the carburetor inlet.

Collectors for the exhaust gas must be so designed as to keep down the back pressure on the engine to a minimum, as excessive back pressure results in detonation. Of course, the gases from the collector impinge directly on the turbine runner, and the pressure of this gas is regulated by the relief valve which releases the gas to the atmosphere. This valve is controlled automatically so as to maintain atmospheric pressure at the carburetor inlet.

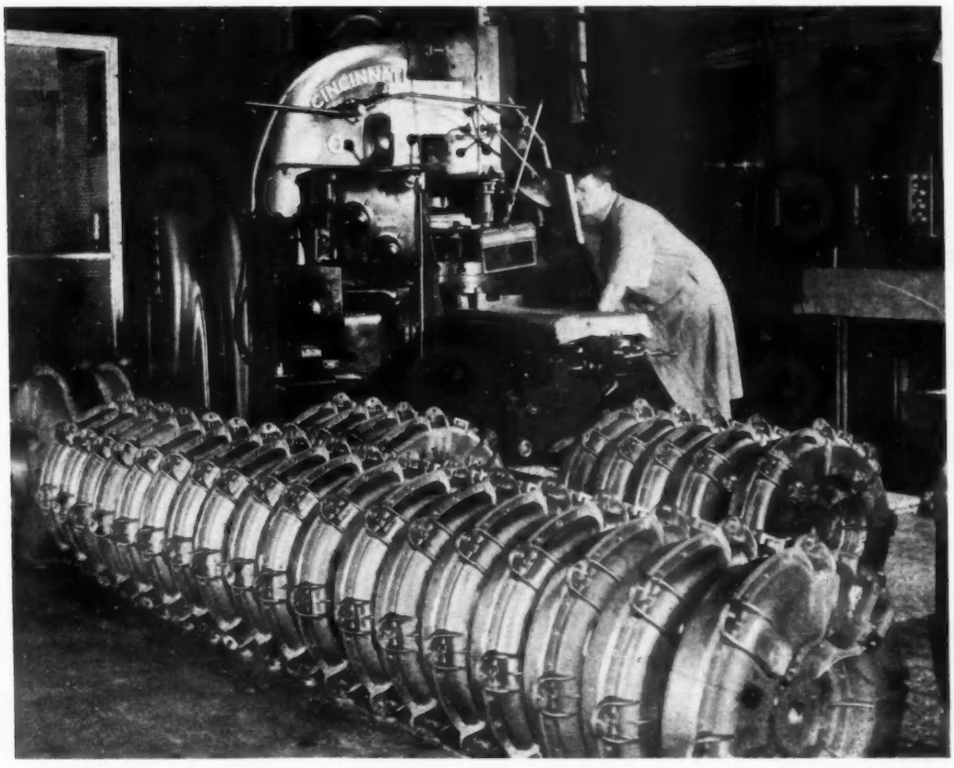


Failure of the turbine wheel due to the high temperatures of the exhaust gases presented a perplexing problem for years. With the advent of heat resistant alloy steels in recent years, this defect was overcome. These parts are the turbine wheel and impeller of one of the early units.

Air leakage between the blower and the carburetor inlet is a serious matter, as it results in a drop in pressure and necessitates operating the supercharger at a higher load factor.

The efficiency of the turbine-type supercharger may be assumed to vary from 43 to 62 per cent and at 30,000 ft. altitude the reduction in the temperature of the air as it leaves the blower and enters the carburetor

(*Turn to page* 31, *please*)



To meet the needs of Uncle Sam's fighting forces, General Electric Co. is turning out hundreds of superchargers each week and two additional plants for the exclusive manufacture of them are being built by General Electric. One of these plants will be opened soon. The latest installation of a turbo - supercharger is separate from the engine. It is mounted in the airframe near the power plant.

Bending Moments

in the Master Rods

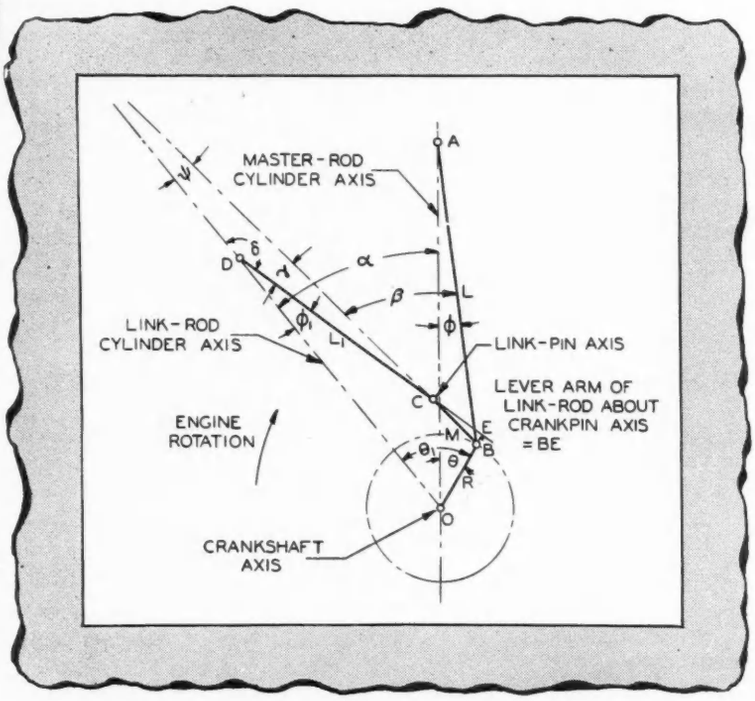


Fig. 1—Diagram of turning moments about crankpin.

By L. Morgan Porter[1]

THE BENDING stress in the column of a master connecting-rod of a radial engine is produced by a turning moment about the center of the crankpin, caused by the action of the articulated or link-rods due to gas pressure and inertia forces, and also due to inertia forces in the master-rod itself.

It has been shown previously by Prof. C. Fayette Taylor[2] that the turning moment produced by inertia forces in the link-rod cylinders is insignificant when compared with the moment caused by the gas forces, and that in aircraft and similar engines, in which the reciprocating weights are relatively small and the maximum speed is moderate, it might well be neglected. It was also shown that the moment caused by the inertia of the master-rod itself, while larger than that caused by the inertia forces in the link-rod cylinders, is likewise much smaller than the moment caused by the gas forces, and that it always opposes the gas load moment. It can, therefore, be neglected and the worst condition figured from the gas-load alone, which condition will exist at full throttle and low speed, when the inertia forces are a minimum and the gas forces are a maximum, as during sudden acceleration from idling speed. Accordingly, in the present study only the gas-load moments were considered, the nature of these turning moments being shown in Fig. 1. The engines used as the basis of this study, which was made while the author was a member of the faculty at New York University, were the Ken-Royce 90, formerly known as the LeBlond 90, and the Wright R-540-E, both engines being five cylinder radial engines, the characteristics of which are given in Table 1.

In the study of the Ken-Royce engine it was thought to be of added interest to widen the scope of investigation by arbitrarily increasing the distance of the link-pin axis from the crankpin axis by ¼ in. and ½ in., to determine the magnitude of the increase in the turning moment produced in each case, so as to arrive at a formula that could be applied to any similar five-cylinder radial engine. For convenience in this report the original engine is designated as engine No. 1, the engine with the link radius increased ¼ in. as engine No. 2, and the engine with the link radius increased ½ in. as engine No. 3. In each case, when the link radius

TABLE 1

Data Regarding Ken-Royce and Wright Radial Aircraft Engines

	KEN-ROYCE	WRIGHT
Type	Air Cooled	Air Cooled
Model	90	R-540-E
Number of Cylinders	5	5
Bore, in.	4.25	5.00
Stroke, in.	3.75	5.50
Total Piston Displacement, cu. in.	266	540
Rated Brake Horsepower	90	175
Rated Speed, R.P.M.	2250	2000
Compression Ratio	6.0	5.1
Length of Master-Rod, center to center, in.	7.75	10.875
Length of Link-Rod, center to center, in.	5.938	8.812
Crank Radius, in.	1.875	2.75
Ratio of Master-Rod Length to Crank Radius	4.133	3.95
Average Radius of Link-Pin Axes, in.	1.858	2.116
Actual Radius of Link-Pin Axes, cyl. 2 and 5, in.	1.878	2.141
Actual Radius of Link-Pin Axes, cyl. 3 and 4, in.	1.837	2.092
Type of Master-Rod	Split	Solid

[1] Engine Designer, Pratt & Whitney Aircraft, East Hartford, Conn., formerly Asst. Prof. of Machine Design, New York University, N. Y. C.

[2] "Bending Moments in the Master Rod of a Radial Aircraft Engine", S.A.E. Trans. 1932, pp. 488-492. S.A.E. Trans. 1933, p. 91. "New Data on the Bending Moments in the Master Connecting-Rod", S.A.E. Journal, June 1933, pp. 26-27; and July 1933, p. 23.

# of Radial Aircraft Engines

was increased, the length of the link-rod was reduced an equal amount, to keep the same cylinder arrangement and overall engine diameter.

Turning Moments Were Determined

An indicator card, Fig. 2, was constructed from the data in Table 1, using the usual methods with a suction pressure of 13 lb. per sq. in. absolute and an overall exponent of 1.3 for expansion and compression curves.[3] While this does not exactly duplicate an actual card, it is sufficiently accurate for design purposes, the same card being used for all cylinders. The gas pressure was taken from this card at 9-deg. intervals throughout the crank rotation. A 9-deg. interval was chosen because the angle between cylinders in a five-cylinder radial engine is 72 deg., thereby giving eight evenly spaced points between cylinders. Only the gas pressures on the compression and expansion strokes were considered, the lower loop of the indicator card being considered as being of relatively very small magnitude. These gas pressures, when divided by the cosine of the angle between the link-rod and its cylinder axis, and multiplied by both the piston area and the effective lever arm about the crankpin, give the gas load turning moments in the master-rod produced by each cylinder.

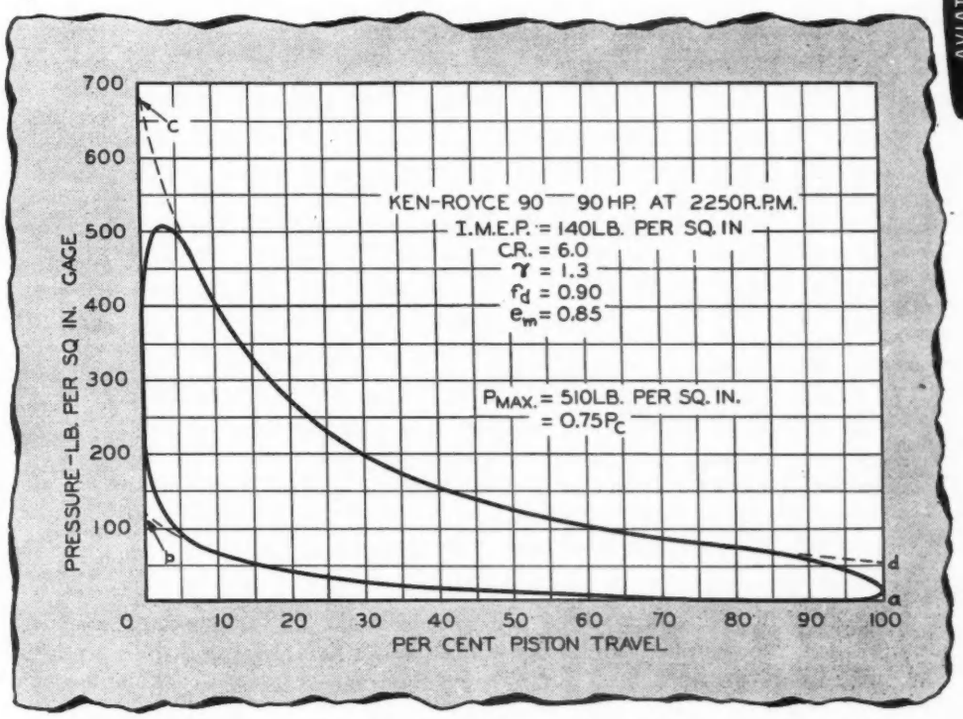


Fig. 2—Indicator card. (The LeBlond 90 is now known as the Ken-Royce 90.)

The angle between each link-rod and its respective cylinder axis was calculated for every 9 deg. of crank travel, measured from the master-rod cylinder axis, the master-rod cylinder being taken as cylinder No. 1. The following equations were used, from which the cosine was readily determined (see Fig. 1).[4]

$$\sin \phi_1 = \frac{1}{L_1}\left[R \sin \theta_1 - M \sin \psi\right] \qquad (1)$$

$$\phi = \phi + [\beta - \alpha] \qquad (2)$$

[3] See air Corps Information Circular No. 421.
[4] See also "Engine Dynamics and Crankshaft Design"—Glenn D. Angle, pp. 13 & 14.

$$\sin \phi = \frac{R}{L} \sin \theta \qquad (3)$$

where

ϕ_1 = angle between link rod and its cylinder axis
L = length of master-rod AB
L_1 = length of link-rod DC
M = link radius (crankpin to link-pin) BC
R = crank radius OB
ψ = angle between link radius and cylinder axis
θ = crank angle from cylinder No. 1
θ_1 = crank angle from link-rod cylinder axis = $\theta + \alpha$
ϕ = angle between master-rod and No. 1 cylinder axis
α = angle between cylinders
β = angle between master-rod axis and link radius

Since $\alpha = \beta$ in the usual type of radial engine, $\psi = \phi$ and Equation (1) may be written

$$\sin \phi_1 = \frac{1}{L_1}\left[R \sin (\theta + \alpha) - M \frac{R}{L} \sin \theta\right] \qquad (4)$$

Equation (4) expresses ϕ_1 as a function of the crank angle θ, the other variables being constant for any one link-rod cylinder. With crank rotation taken clock-

TABLE 1A

Calculations For Engine No. 1 — Cyl. Nos. 2 and 5

$L_1 = 5.938$, $M = 1.878$, $K_1 = 0.3158$, $K_2 = 0.0765$

$L = 7.75$, $R = 1.875$, $L/R = 4.133$

$\text{Sin } \phi_1 = K_1 \text{ Sin } (\theta + \alpha) - K_2 \text{ Sin } \theta$

$\alpha = 288$ For Cyl. 2

$\alpha = 72$ For Cyl. 5

$\text{Sin } \phi = \frac{R}{L} \text{ Sin } \theta$

$\gamma = \phi_1 - \phi$

Values For Cyl. 2

Crank Angle From Cyl. 1	Sin θ	K_2 Sin θ	θ + 288	Sin (θ+288)	K_1 Sin (θ+288)	Sin ϕ_1	Cos ϕ_1	Angles in Deg. and Min. ϕ_1	ϕ	γ	Sin γ	Lever Arm = M Sin γ	Values of θ For Cyl. 5
0	0	0	288	-.9511	-.3005	-.3005	0.9538	-17-29	0	-17-29	-.3005	-.563	180
9	0.1564	0.0120	297	-.8910	-.281	-.2930	0.9561	-17-2	2-10	-19-12	-.3289	-.617	171
18	0.3090	0.0237	306	-.8090	-.255	-.2787	0.9604	-16-11	4-17	-20-28	-.3497	-.656	162
27	0.4540	0.0348	315	-.7071	-.223	-.2578	0.9662	-14-56	6-19	-21-15	-.3624	-.680	153
36	0.5878	0.0450	324	-.5878	-.1855	-.2305	0.9731	-13-20	8-10	-21-30	-.3665	-.688	144
45	0.7071	0.0542	333	-.4540	-.1435	-.1977	0.9803	-11-24	9-51	-21-15	-.3624	-.680	135
54	0.8090	0.0619	342	-.3090	-.0975	-.1594	0.9872	- 9-10	11-17	-20-27	-.3494	-.656	126
63	0.8910	0.0682	351	-.1564	-.0494	-.1176	0.9931	- 6-45	12-27	-19-12	-.3289	-.617	117
72	0.9511	0.0728	360	0	0	-.0728	0.9973	- 4-10	13-18	-17-28	-.3002	-.563	108
81	0.9877	0.0755	9	0.1564	0.0494	-.0261	0.9997	- 1-30	13-49	-15-19	-.2642	-.496	99
90	1.0000	0.0765	18	0.3090	0.0975	0.0210	0.9998	1-12	14-0	-12-48	-.2216	-.416	90
99	0.9877	0.0755	27	0.4540	0.1435	0.0680	0.9977	3-54	13-49	- 9-55	-.1722	-.323	81
108	0.9511	0.0728	36	0.5878	0.1855	0.1127	0.9936	6-28	13-18	- 6-50	-.1190	-.2235	72
117	0.8910	0.0682	45	0.7071	0.223	0.1548	0.9879	8-54	12-27	- 3-33	-.0619	-.116	63
126	0.8090	0.0619	54	0.8090	0.255	0.1931	0.9812	11-8	11-17	- 0-9	-.0026	-.0049	54
135	0.7071	0.0542	63	0.8910	0.281	0.2268	0.9739	13-7	9-51	3-16	0.0570	0.107	45
144	0.5878	0.0450	72	0.9511	0.3005	0.2555	0.9668	14-48	8-10	6-38	0.1155	0.217	36
153	0.4540	0.0348	81	0.9877	0.312	0.2772	0.9608	16-6	6-19	9-47	0.1699	0.319	27
162	0.3090	0.0237	90	1.0000	0.3158	0.2921	0.9564	16-59	4-17	12-42	0.2199	0.413	18
171	0.1564	0.0120	99	0.9877	0.312	0.3000	0.9539	17-28	2-10	15-18	0.2639	0.495	9
180	0	0	108	0.9511	0.3005	0.3005	0.9538	17-29	0	17-29	0.3005	0.563	0
189	-.1564	-.0120	117	0.8910	0.281	0.2930	0.9561	17-2	- 2-10	19-12	0.3289	0.617	351
198	-.3090	-.0237	126	0.8090	0.255	0.2787	0.9604	16-11	- 4-17	20-28	0.3497	0.656	342
207	-.4540	-.0348	135	0.7071	0.223	0.2578	0.9662	14-56	- 6-19	21-15	0.3624	0.680	333
216	-.5878	-.0450	144	0.5878	0.1855	0.2305	0.9731	13-20	- 8-10	21-30	0.3665	0.688	324
225	-.7071	-.0542	153	0.4540	0.1435	0.1977	0.9803	11-24	- 9-51	21-15	0.3624	0.680	315
234	-.8090	-.0619	162	0.3090	0.0975	0.1594	0.9872	9-10	-11-17	20-27	0.3494	0.656	306
243	-.8910	-.0682	171	0.1564	0.0494	0.1176	0.9931	6-45	-12-27	19-12	0.3289	0.617	297
252	-.9511	-.0728	180	0	0	0.0728	0.9973	4-10	-13-18	17-28	0.3002	0.563	288
261	-.9877	-.0755	189	-.1564	-.0494	0.0261	0.9997	1-30	-13-49	15-19	0.2642	0.496	279
270	-1.0000	-.0765	198	-.3090	-.0975	-.0210	0.9998	- 1-12	-14-0	12-48	0.2216	0.416	270
279	-.9877	-.0755	207	-.4540	-.1435	-.0680	0.9977	- 3-54	-13-49	9-55	0.1722	0.323	261
288	-.9511	-.0728	216	-.5878	-.1855	-.1127	0.9936	- 6-28	-13-18	6-50	0.1190	0.2235	252
297	-.8910	-.0682	225	-.7071	-.223	-.1548	0.9879	- 8-54	-12-27	3-33	0.0619	0.116	243
306	-.8090	-.0619	234	-.8090	-.255	-.1931	0.9812	-11-8	-11-17	0-9	0.0026	0.0049	234
315	-.7071	-.0542	243	-.8910	-.281	-.2268	0.9739	-13-7	- 9-51	- 3-16	-.0570	-.107	225
324	-.5878	-.0450	252	-.9511	-.3005	-.2555	0.9668	-14-48	- 8-10	- 6-38	-.1155	-.217	216
333	-.4540	-.0348	261	-.9877	-.312	-.2772	0.9608	-16-6	- 6-19	- 9-47	-.1699	-.319	207
342	-.3090	-.0237	270	-1.0000	-.3158	-.2921	0.9564	-16-59	- 4-17	-12-42	-.2199	-.413	198
351	-.1564	-.0120	279	-.9877	-.312	-.3000	0.9539	-17-28	- 2-10	-15-18	-.2639	-.495	189
360	0	0	288	-.9511	-.3005	-.3005	0.9538	-17-29	0	-17-29	-.3005	-.563	180

wise Fig. 1, note that $\alpha = 72$ deg. for cylinder No. 5; 144 deg. for cylinder No. 4; 216 deg. for cylinder No. 3 and 288 deg. for cylinder No. 2. The actual values of the link radius M were used for the different cylinders (Table 1).

Equation (4) may be written

$$\sin \phi_1 = K_1 \sin (\theta + \alpha) - K_2 \sin \theta \qquad (4a)$$

where K_1 and K_2 are constants, K_1 being the same for all link-rod cylinders and K_2 having one value for cylinders Nos. 2 and 5, and another value for cylinders Nos. 3 and 4. The calculations were done in tabular form and careful attention was given to the algebraic sign, values of sin ϕ_1 and cos ϕ_1, being determined for crank angle values from zero to 360 deg. Values of the angle ϕ_1 were also noted for use in later calculations.

Due to the repeating nature of the sine, the calculations for all four link-rod cylinders are not as tedious as one might at first think. Also, due to the mirror similarity between both sides of the engine, the calculations for cylinder No. 2 may be made applicable to cylinder No. 5 by taking the crank angles backwards and reversing the algebraic sign. By the simple expedient of using another column for the crank angle θ for cylinder No. 5, putting the value of zero deg. opposite the computed values for 180 deg. for cylinder No. 2, and numbering up for the succeeding values of θ for cylinder No. 5, the algebraic sign takes care of itself and values of sin ϕ_1, cos ϕ_1, and ϕ_1 may be read directly. Values for cylinder No. 5 when θ is 9 deg. are the same both in amount and algebraic sign as the values for cylinder No. 2 when θ is 171 deg. A similar reasoning applies to cylinders Nos. 3 and 4. See Table 1A.

The top dead center position of each link-rod cylinder was taken at a crank angle from the master-rod cylinder axis equal to the angle between the master-rod cylinder axis and the link-rod cylinder axis in question. While this is not absolutely correct, it is probably close enough for practical purposes.

Referring to Fig. 1, it is seen that $\gamma = 180$ deg. $- \psi - \delta$, where γ is the angle between the link radius and the link-rod, and δ is the obtuse angle between the link-rod and the cylinder axis and equal to 180 $- \phi_1$. Other notations are the same as before. Also the lever arm BE of the link-rod about the crankpin is equal to M sin γ. Substituting the value of δ given above, and since, as shown previously $\psi = \phi$ in the usual type of radial engine, the expression for γ becomes simply,

$$\gamma = \phi_1 - \phi \qquad (5)$$

Since ϕ is readily determined from Equation (3) in terms of the crank angle θ, and since the values of ϕ_1 have already been found in terms of crank angle θ, it is a relatively simple matter to compute the corresponding lever arms for all the link-rod cylinders. The same remarks about making the calculations of sin ϕ_1, etc., for cylinder No. 2 applicable to cylinder No. 5 apply in the determination of the values of γ and the lever arms, thus greatly simplifying the work.

It should be pointed out that in using Equation (5) careful attention must be given to the algebraic sign of ϕ_1 and ϕ. With both of these angles taken as posi-

TABLE 2

Comparison of Turning Moments

Cyl. No.	Occurs Deg. A.T.C. All Engines*	Wright R-540-E Moment Lb.-In.	Engine No. 1 Ken-Royce Moment Lb.-In.	Engine No. 2. Link Radius Increased 1/4" Moment Lb.-In.	Engine No. 2. Link Radius Increased 1/4" % Increase Over Eng. 1	Engine No. 3. Link Radius Increased 1/2" Moment Lb.-In.	Engine No. 3. Link Radius Increased 1/2" % Increase Over Eng. 1
2	9	-4890	-3280	-3860	17.7	-4510	37.5
3	54	3570	2190	2600	18.7	3040	38.8
4	27	7740	5080	6050	19.1	7120	40.2
5	18	6925	4810	5700	18.5	6670	38.6

* Deg. A.T.C. for Cylinder in Question.

Plus Moment is Clockwise About Crankpin When Viewed With Clockwise Engine Rotation.

Maximum Resultant Moments

	Due Mainly to Cyl. No.						
Peak 1	4	7950	5310	6300	18.7	7440	40.1
Peak 2	5	7240	5100	6020	18.1	7050	38.2
Peak 3	2	-5135	-3490	-4120	18.1	-4810	37.8
Peak 4	3	3485	2130	2530	18.8	2965	39.2
Peak 5	3	-2830	-1960	-2330	18.9	-2725	39.0

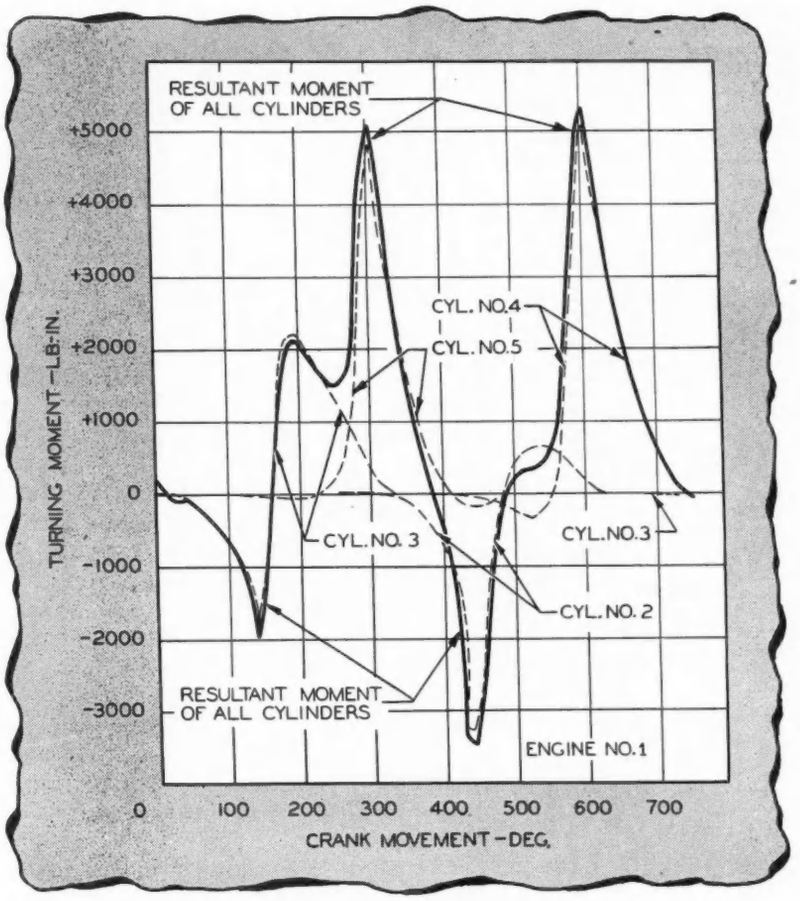


Fig. 3—Turning moments exerted on master rod by gas pressure on link rods.

tive in the position shown in Fig. 1, the resulting sign of γ, and hence the lever arm, is such that a positive sign indicates a positive or clockwise turning moment about the crankpin, and a negative sign a negative or counter-clockwise moment. The angle ϕ_1 must be taken as negative when sin ϕ_1 is negative, and the angle ϕ must be taken as negative for values of the crank angle θ from 180 to 360 deg. A sample set of calculations in tabular form is shown in the Appendix, which will appear in part two of this article.

Results

The results of this investigation are shown by the curves in Figs. 3 and 4 for the Ken-Royce engine No. 1. Fig. 3 shows the turning moments produced by the gas forces in each of the four link-rod cylinders, together with the resultant moment due to all four cylinders combined, all plotted against the crank angle measured from the master-rod cylinder axis, the master-rod cylinder being considered as cylinder No. 1. Fig. 4 shows the variation of the respective lever arms in each of the link-rod cylinders, together with the peak of the gas pressure for each cylinder in its proper phase relation, all plotted against crank angle from cylinder No. 1. The results from engines Nos. 2 and 3 and for the Wright engine are not shown in curve form, inasmuch as they are similar in nature, the maxima occurring at the same crank angles. However, the significant peaks in the curves of the turning moments and lever arms are given for all engines in Tables 2 and 3, for comparison.

Referring to Fig. 3 and Table 2, it is seen that all the peaks in the resultant gas-moment curve are due mainly to the firing of individual cylinders. This was to be expected, since similar results were found by Professor Taylor for seven- and nine-cylinder engines, and with fewer cylinders the peaks naturally would be more dependent on individual cylinders than with a greater number of firing impulses per revolution. The peaks in the order of their magnitude are caused by cylinders Nos. 4, 5, 2, and 3, respectively, with cylinder No. 3 causing a positive and a negative peak. With the exception of cylinder No. 3, the maximum moment in any one cylinder occurs shortly after the firing top dead center of the particular cylinder, when the gas pressure is a maximum, occurring at 9, 27 and 18 deg. after top dead center for cylinders Nos. 2, 4, and 5, respectively. Due to the fact that calculations were made only at 9-deg. intervals of crank travel and the assumption made for top dead center in any one link-rod cylinder, these figures should be taken as approximate only. In each case the gas peak was taken as occurring at 18 deg. past top dead center.

The magnitude of the negative peak caused by cylinder No. 2 is of interest, since it gives an insight into the amount of the stress reversal in the master-rod due to the change in sign of the turning moment. This is an important point when considering fatigue failure, and may account for some of the connecting-rod failures that have occurred in the past during the development stage.

Comparing the moments produced by the individual cylinders, it is seen that cylinder No. 4 causes the largest moment, followed closely by cylinder No. 5, with cylinder No. 2 being quite a bit less and cylinder No. 3 causing the smallest moment. Inspection of Fig. 4 shows that the lever arms for cylinders Nos. 3 and 4 are somewhat larger than those for cylinders Nos.

TABLE 3

Comparison of Lever Arms

	Wright R-540-E Lever Arm, In.	Engine No. 1 Ken-Royce Lever Arm, In.	Engine No. 2 Lever Arm, In.	Engine No. 2 % Increase Over Eng. 1	Engine No. 3 Lever Arm, In.	Engine No. 3 % Increase Over Eng. 1
Cyl. 2 and 5	±0.775	±0.688	±0.814	18.3	±0.950	38.1
Cyl. 3 and 4	±1.190	±1.058	±1.250	18.2	±1.458	37.8

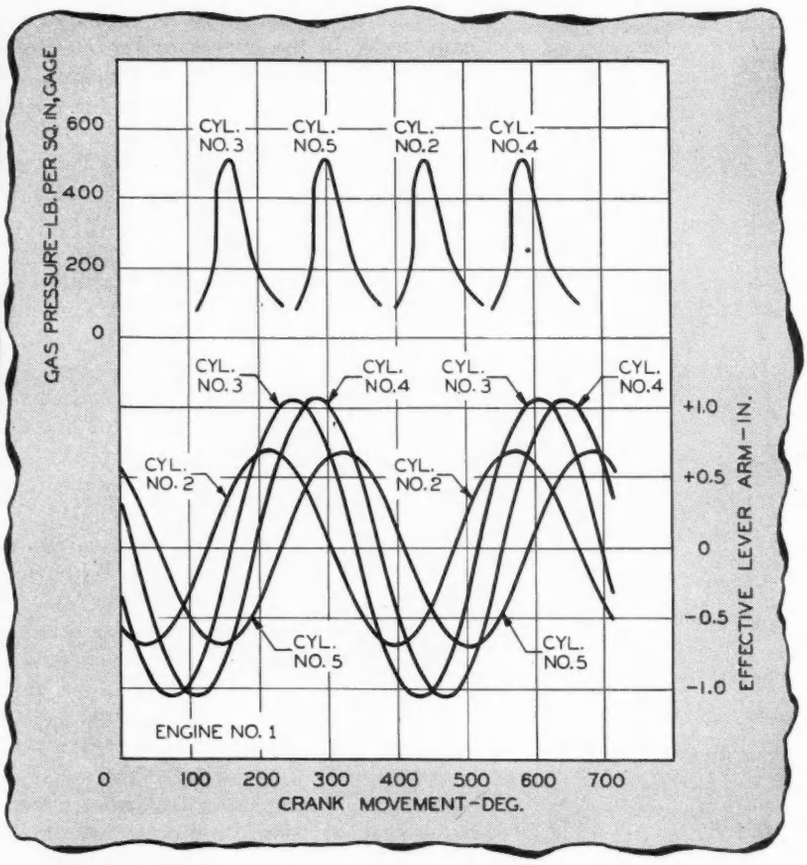


Fig. 4—Lever arms and gas pressure vs. crank moment.

2 and 5, which would cause one to infer that the moments caused by these cylinders would be larger than those caused by the other two cylinders. However, on examining the curves for the lever arms and the gas pressure peaks together, it is seen that the gas peak in cylinder No. 4 occurs when the lever arm has a value about equal to the maximum value for cylinders Nos. 2 and 5, and that the lever arm is still increasing more rapidly than the gas pressure is decreasing, causing the maximum moment to occur shortly after the gas peak. In the case of cylinder No. 5 the gas peak occurs when the lever arm is almost at its maximum value and increasing slowly, resulting in a maximum moment slightly less than that produced by cylinder No. 4. Coming now to cylinder No. 2, we observe that the lever arm is well past its peak value and decreasing rapidly when the gas pressure is at its maximum. Finally, in the case of cylinder No. 3, the rather startling observation is made that the lever arm is passing through its zero value when the gas pressure peak occurs. This accounts for the fact that the maximum moment occurs well past top dead center and the fact that there is an almost equally large negative moment occurring approximately at top dead center when the lever arm has a negative value and the gas pressure is rising rapidly. It is of interest to note that at a crank angle of 200 deg. the resultant moment of all cylinders is slightly less than the peak for cylinder No. 3, due to the slight negative moment caused by cylinder No. 5 at that time.

The actual bending moment at any section of the master connecting-rod is readily found by dividing the turning moment around the crankpin by the length of the connecting-rod from crankpin center to piston-pin center, and multiplying by the distance from the piston-pin center to the section in question. Using the maximum turning moment in the Ken-Royce engine No. 1, the maximum bending stress is found to be 19,600 lb. per sq. in. This stress occurs at section A-A in Fig. 5, approximately in the center of the connecting-rod, where it can be seen that the section modulus increases more rapidly than the bending moment for sections nearer the crankpin. The negative moment, caused mostly by cylinder No. 2, produces a stress of 12,900 lb. per sq. in. in the opposite direction, giving a total stress range of 32,500 lb. per sq. in. On referring to Fig. 3, since cylinder No. 5 causes a positive moment almost as large as that caused by cylinder No. 4, it is seen that two large stress reversals take place in about 300 deg. of crank travel. This, of course, is repeated every cycle.

Applying the column formula given in the standard methods of engine calculations[3], the stress caused by the gas loads in the master-rod cylinder is found to be 18,340 lb. per sq. in. about the X axis, and 18,790 lb. per sq. in. about the Y axis. It is to be noted that the bending stress exceeds the column stress. These stresses are not additive, since they do not occur at the same time. The maximum bending stress occurs at a crank angle of 603 deg. from the master-rod cylinder, at a time when the latter cylinder has a very small pressure on the compression stroke. The other significant peaks at crank angles of 306 and 441 deg. also take place when the gas pressure is practically zero, occurring at about three-fourths of the upward piston motion on the exhaust stroke for

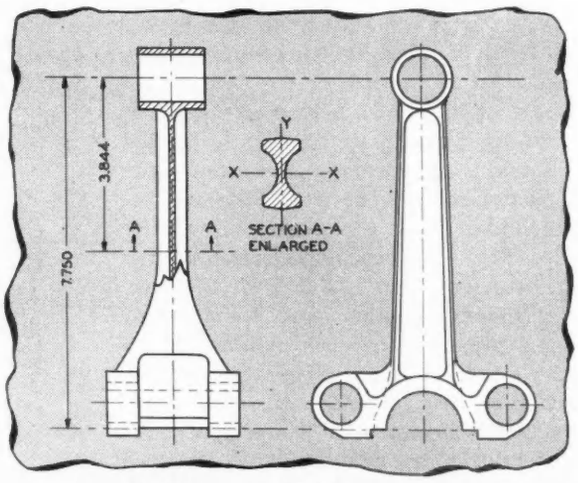


Fig. 5—Master rod of Ken-Royce engine.

the former and at about one-half the downward motion on the intake stroke for the latter. When the maximum column stress occurs, shortly after top dead center of the master-rod cylinder, the turning moment, and hence the bending moment, is practically zero, as can be seen from Fig. 3.

The maximum bending stress in the master-rod of the R-540-E is found to be 15,150 lb. per sq. in., and the negative moment produces a bending stress of 9780 lb. per sq. in., giving a total stress range of 24,930 lb. per sq. in. The column stress figured for

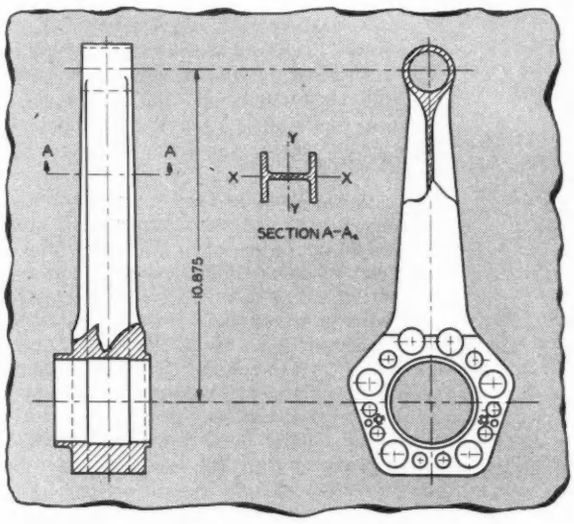


Fig. 6—Master rod of Wright R-540-E.

the section in the center of the master-rod, using the maximum gas pressure, is 11,300 lb. per sq. in. about the X axis and 9230 lb. per sq. in. about the Y axis. Here again the maximum bending stress is greater than the column stress. It is to be noted that the R-540-E employs an H-section connecting-rod, Fig. 6, and that due to the fairly rapid change in section modulus, the maximum bending stress does not occur near the big end, where the bending moment is a maximum but occurs about 3½ in. from the small end of

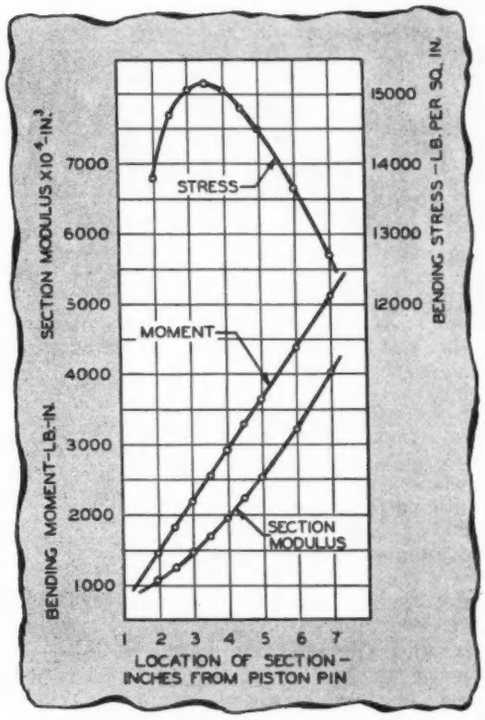


Fig. 7—Bending stress in master rod of Wright R-540-E due to link rods.

the rod. This is shown in Fig. 7, where the bending moments, section moduli and stresses are plotted for different sections. Other things remaining the same, this would suggest a possible saving in weight by decreasing the taper of the connecting-rod shank in order to make the bending stress more nearly uniform throughout.

PART TWO *of*

Bending Moments in the Master Rods of Radial Aircraft Engines

Will Appear in an Early Issue

Superchargers for Aircraft Engines

(*Continued from page* 25)

may vary between 100 and 200 deg. F. In poor installations the drop may be from 380 to 100 deg. F.

All types of superchargers, and especially the air inlets, must be carefully designed, as any drop in pressure results in severe power loss.

The supercharger development originally instituted at McCook Field has constantly been in collaboration with Dr. Sanford A. Moss, of the General Electric Co., who has been responsible for the design of practically all of the supercharger units used in American aircraft engines so the choice of any one type of supercharger for a specific purpose has been founded on engineering requirements and not on a prejudiced preference for any one type.

Summing up, I think it is reasonable to state that in radial, air-cooled engines which are to fly at reasonable altitudes, the present type of built-in, gear-driven supercharger is the most satisfactory. For "in line" engines which are to fly at reasonable altitudes, a gear-driven supercharger may be used, but it should deliver the air through an aircooler. Engines which are to fly at very high altitudes will be more efficient if fitted with the turbine-driven type of supercharger, as in the larger engines the power to be transmitted is so great that it becomes very difficult to avoid high stresses and high unit loadings of clutch facings, gear teeth, and bearings. Moreover, it becomes difficult to properly cool the air or mixture during its passage from the blower to the cylinder inlet, which is necessary to avoid power loss and detonation.

AVIATION INDUSTRIES

Airbriefs

By HENRY LOWE BROWNBACK

Gyroscopes

We all remember the little flywheel-like tops in a cage with which we played as youngsters and how they stayed put in most amazing positions. How few of us ever dreamed that this same principle would be used to operate automatic pilots and compasses which indicate the true and not the magnetic north, would drop bombs, indicate to gunners how to aim anti-aircraft guns and work machine gun and dive bombing sights. Little flywheels spinning 140,000 and more revolutions per minute show an artificial horizon on an instrument board and indicate the banking and turning. A child's toy has been put to work as an almost magical instrument.

Two-Stroke Engines

The early history of American aviation was written to a large extent by the two-stroke engine and who of us in it in the early days will ever forget the Elbridge, Fox and Roberts engines?

Hard starting in cold weather, poor lubrication and excessive fuel consumption have been the enemy of the two-stroke engine. Direct fuel injection, "U" cylinders, and improved lubricants can change all of this. In fact some of the leading experts in this country today are experimenting with unusual two-stroke designs (Mr. Kettering among them) and something will certainly result.

Some recent tests with special two-stroke engine lubricants for use in the garden variety of crankcase compression engines where the fuel is mixed with the oil have produced remarkable results. For light planes, this type of engine is far from being a dead issue.

Airport Lights

The note on the "retracting" airport border lights which was printed in the last issue of Airbriefs caused so much comment that I am passing along news of another development which has come from the blackout technique used in France prior to the fall of that country.

When the blackout was being arranged it was soon realized that simply "pulling the switch" would not do as certain numbers of blue lights had to be left on as traffic guides and the problem was how to control the lights without digging up the streets to put in control wires. The solution was very clever. Relays, sensitive to a certain electrical frequency, were placed on the lights and these frequencies were then superimposed on the normal current passing to the lights. The sensitive relays would react to their particular frequency and turn on or off the lights to which they were affixed when it was sent over the light wires.

This system was also used at airports to control the different lights. In this manner the entire added apparatus was simply the sending machines at the control stations and a relay switch on each lamp post or light.

Wooden Airplanes

With all of the cry for conservation of aluminum and tubing, it has often struck me that we are "missing the boat" somewhat in our construction of training planes by neglecting the plywood fuselage and wood and fabric or plywood covered wings. Both have been most satisfactory in Europe and the latest British bombing and navigating trainer, the Snargasheris, is built thus and powered with two "in line" 205 hp. engines.

Compound Engines

Early in the days of steam engine building engineers devised a scheme to extract all possible energy from the steam by using the exhaust from one cylinder to operate another in series with it until the exhaust from the last was pumped out by a vacuum pump. In this manner every bit of the heat stored in the steam was extracted and turned into power.

The first attempt with a gasoline engine I can remember was most unique and was used in a motor car built in Philadelphia called the "Compound," in which a three-cylinder engine was installed. This engine has two four-stroke cycle cylinders exhausting into one two-stroke cycle cylinder on the theory or hope that the unburned fuel in the exhaust could be burned in the "compound" cylinder. Since then several attempts have been made including passing the exhaust through a boiler and running a steam cylinder attached to the gasoline engine crankshaft.

The Army has been experimenting with a compound engine in which the high pressure cylinder exhausts into a low pressure cylinder that serves to recover power and to supercharge the main cylinder.

The turbo-supercharger is, in fact, a compound engine as the exhaust from the main engine is expanded through a turbine, which drives a blower that in turn supercharges the main engine increasing its power and thus uses the energy of the main exhaust to increase power. All of these interesting developments bring fuel consumption down and thus increase range and payload.

Tires

Everything from "Flivver" planes to 82-ton bombers are taken off and landed on pneumatic tires and just one bullet can put one of these important adjuncts out of commission and wreck a two hundred thousand dollar bomber. A recent tire development does away with inflated tires and claims superior results to those given by the pneumatic, according to reports.

Navigation

It has always been a problem to the navigator to try and figure out a course knowing the speed of the plane and the drift of a side wind when it has to be done from a machine which changes its position about three miles every minute or about 20 to 30 miles while a calculation is being made. This is now being done, even on one-man planes, in a couple of seconds by the use of ingenious little machines which turn out an answer so fast that it takes your breath away.

Invisible Light

The use of light rays, invisible to the eye, particularly the ultra-violet rays, dates back to the last war and such lights, made visible by filters, are now being widely used for everything from signalling to the headlights of armored cars. The fact that many electrical cells respond to this invisible light opens up a path of investigation which staggers the imagination and can be used from everything from detection of anything passing through the beam to the operation of mantraps not unlike the shotgun with the string attached to the trigger used by the oldtime farmers to catch chicken thieves. These modern mantraps can fire machine guns as soon as anyone crosses the path of an invisible lightbeam.

Welding of Aluminum

It appears that the spot welding of aluminum, a difficult job at best because of the high electrical and thermal conductivity of the metal, is aggravated by the oxide film always present on the parts. It is stated that a chemical cleaning of the aluminum to remove the oxide immediately prior to welding aids greatly.

Scout Cars

The tire well in the wing of the B-19 will accommodate a "Jeep." This gives some idea of the size of this ship.

PRODUCTION LINES

Reference Oil

Latest report of the Independent Research Committee on Cutting Fluids indicates that over 25 different organizations are testing the new "reference oil" developed by the committee. This is indeed encouraging news. When the returns are in, we may be able to present a valuable progress report on current metal cutting practice. Incidentally, the committee will welcome other requests for the reference oil from people who are in a position to use the material on metal cutting operations.

Sub Contracts

It is of interest to find that the Defense Contract Division of OPM is controlling the amount of component parts manufacture on the part of the prime contractor, making it mandatory to farm out a certain percentage of parts. At the start this is bound to work some hardships. It slows down the initial activity on the part of the contractor since he can no longer plan a rational production program completely within his control. Too, the sub-contracting procedure is bound to increase costs in many instances. In the long run, however, the sub-contracting should prove to be a boon to the industry. For one thing it will spread the work among many small manufacturers whose civilian supply activity already has been severely curtailed. Moreover, this procedure should make it possible to start the necessary defense work without waiting for new machine tools—assuming that much of the equipment now on hand can be converted for defense purposes.

Cutting Fluids

So much progress has been made recently in metal cutting and in the utilization of cutting fluids that a number of organizations have found it expedient to record this progress in new or revised literature. An outstanding example of this is found in a new brochure entitled, "Cutting Fluids" just issued by the Esso Marketers group. This booklet covers in some details the current knowledge concerning metal cutting, the selection of cutting fluids, suggestions on handling cutting fluids, industrial dermatitis. This is followed by a section dealing with the Esso Marketers line of cutting fluids; cutting pastes; cutting tool materials; and tables on machinability ratings of metals, recommendations for cutting fluids applications.

Along the same line is a booklet — "Metal Cutting Lubrication" just issued by the Cities Service Oil group. This contains considerable data on current studies of metal cutting — both theoretical and experimental—on friction and chip formation, on the "built-up" edge, on addition agents, etc. The latter part of the booklet is concerned with a discussion of cutting fluid practice, election of cutting fluids. Finally there is a section devoted to cutting fluid recommendation charts, including a classification of metals according to machinability ratings.

We urge a reading of both brochures. They should be on your bookshelf and we shall be glad to get your copies on request. Just ask us.

Describes Equipment

We are in receipt of a handsome spiral-bound brochure illustrating many of the new Cincinnati machines for milling, broaching, die sinking, grinding, and lapping. Each of these machines is described briefly but comprehensively with specifications data of value to factory executives. It is particularly valuable at a time when many organizations are studying equipment details for new defense plants and for expanding activity in existing plants. Ask us for a copy.—J. G.

Aviation at Top Speed

(*Continued from page* 21)

and will reach over 8000 a year from now. The goal is 12,500 per month, which can be reached with proper preparation, bearing in mind that two years ago 400 per month was good production.

American engineers have produced the first practical substratosphere bomber, the first dependable production engines over 2000 hp., cruising fuel economy comparable to Diesel and superior to fuel injection of the Germans, the world's fastest pursuit ship, and fastest dive bomber, the world's largest bomber, medium bombers with the speed of pursuit ships, the world's most accurate bomb sight, the constant-speed and controllable-pitch propeller; all in a short time.

The limit of power is not known, but 3000 hp. is near, and 4000 contemplated. Meantime, we have 2000 dependable horsepower. There has been much controversy over the merits of the air-cooled and liquid-cooled engines. As higher power is developed, you may expect to see the radial use more rows and the liquid-cooled use more banks, so that in appearance the two will resemble each other more and more.

Many new engines are being worked on, some of which cannot be discussed. Chrysler is planning an inverted V-type, 16-cylinder, liquid-cooled engine of 2000 hp. Ford is developing a V-12 liquid-cooled engine of about 2000 hp.; using cast liners, crankshaft and camshaft; fuel injection and turbo supercharging. Lycoming has developed a flat, opposed engine, the design lending itself to wing installation. The engineering executives of our leading engine companies have shown sound judgment in putting into production types which they know they can build, and which are dependable.

Germany achieved aircraft production by a definitely planned, but uneconomical method, illustrated by the aircraft engine program, as follows:

First, they procured foreign engines, thus saving much time on design.

Second, they developed a great many parts and accessories specialists, similar to our American system.

Third, the Air Ministry directed the entire policy, which would have put any self-sustaining engine company into bankruptcy, and which I wish particularly to say is not recommended, because it is part of the professional system. One company built only one type of engine, and one model of that type, whereas our engine companies must build many models and types. Practically all the engines produced in Germany were taken by the German government.

Fourth, two companies were assigned to the same problem. B.M.W. and Bramo built large air-cooled engines; Junkers and Daimler Benz, liquid-cooled engines; Argus and Hirth, training engines. There were two non-competing conference groups, each with full research facilities, and results from any one were available to the entire industry.

Fifth, each engine company was organized as follows: A—Development Factory; B—Experimental Factory; C—Production Factory; D—Licensees.

The program explains the large engine production, and was quite similar to the plane program. The German material is well built, and the story of building for 14 hours' service is a fallacy. I personally inspected the fuel injection system—it was well made. War came with only one nation—the professional—prepared.

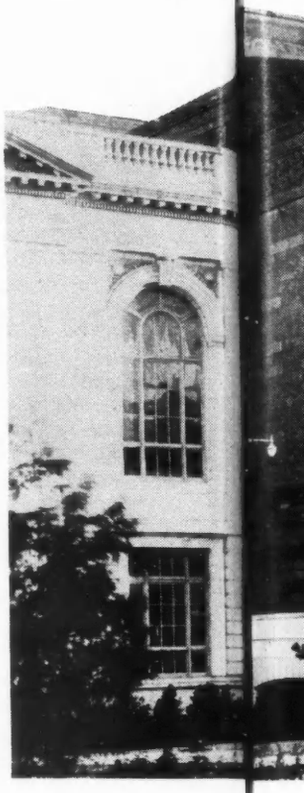
Twenty-third National Metal

COMBINING the metal world's largest industrial exhibit and a series of important technical sessions, the National Metal Congress and Exposition will be held in Philadelphia for five days beginning Oct. 20. Its general theme will be, "New Aids to National Defense Production," and in attendance at the forum meetings on defense problems will be outstanding authorities on the manufacture, production and fabrication of metals. These defense meetings will present more than a hundred specialists actively engaged in either industrial defense activities or government planning in the present emergency. Hundreds of exhibitors will show their newest aids for speeding defense production.

This congress and exhibit is expected to be the largest in the 23-year history of the event. More than 105,000 sq. ft. of exhibit space have been taken by exhibitors representing every branch of the metals and associated industries. Extensive technical programs of the American Society for Metals, American Welding Society, Wire Association, and the Iron and Steel division and the Institute of Metals division of the American Institute of Mining and Metallurgical Engineers will be held in conjunction with the show. Technical sessions are generally scheduled to be held in Philadelphia hotels as well as at the larger meeting rooms in the Convention Hall.

The American Society for Metals' technical program will present 60 papers in 14 sessions and will include a symposium on "Controlled Atmospheres," a lecture course to be presented on Thursday and Friday mornings, and defense meetings with high ranking officials of the War Department, Navy Department and Supply Priorities and Allocations Board in attendance. The Edward de Mille Campbell Memorial Lecture will be delivered on Wednesday morning following the annual meeting of the American Society for Metals. This year's Campbell Memorial Lecture will be by Dr. Robert F. Mehl of Carnegie Institute of Technology. The educational lectures on the ASM program include daily talks by J. B. Austin of the U. S. Steel Corp., on "Heat Flow in Metals." Three evening lectures in the educational series will be delivered by S. R. Williams of Amherst College on the subject "Hardness and Hardness Measurements." The banquet will be held on Thursday evening at Hotel Benjamin Franklin. Headquarters for ASM will also be at this hotel with morning technical sessions, afternoon and evening lectures to be held at the Convention Hall and Commercial Museum.

Defense group meetings of the American Society for Metals will be "off the record" and will start Monday afternoon when Gordon T. Williams of John Deere & Co. will conduct the discussions on "Low Carbon Alloy Steels" (Case Hardening Steels).



Convention Hall, Philadelphia, where the twenty-third Metal Congress and Exposition will be held.

Summarizer will be O. W. McMullan, Youngstown Sheet & Tube Co. One Monday evening session deals with the "Manufacture of Shells." Its chairman is Prof. A. F. Macconochie, head of the department of mechanical engineering at the University of Virginia. C. B. Dakin of the General Motors Shell Plant will summarize. The Monday evening sessions also include "Problems in the Fabrication of Aluminum Base Alloys and Magnesium Base Alloys for Defense Material." E. H. Dix, Jr., of the Aluminum Co. of America is the leader and Harry Huester of the Raynolds Metal Co. the summarizer.

The Tuesday afternoon meeting deals with "Higher Alloy Steels" (oil quenching steels). Dr. M. A. Grossmann of the Carnegie-Illinois Steel Co. will lead the discussion. Harry McQuaid of Republic Steel Co. will be summarized. On Tuesday evening "Copper and Its Alloys in National Defense" will be discussed. Harry Croft of the Chase Brass & Copper Co. will lead the discussion. Maj. Leslie Fletcher of Frankford Arsenal is named as summarizer. "Stainless and Heat Resisting Steels" will be the topic on the second half of the Tuesday evening discussions. A. L. Field of the Rustless Iron & Steel Co. will direct the discussion of steel, while R. J. McKay of the International Nickel Co.

Congress and Exposition

will be leader of the "corrosion" portions of the meeting.

On Wednesday afternoon "High Strength, Low Alloy Steels" (Weldable Grades for Pressure Vessels, Piping, Ships and Rolling Stock) will occupy the attention of the defense group meeting with Col. G. F. Jenks, U. S. Army Ordnance, presiding. Colonel Jenks is president of the American Welding Society. Dr. James C. Hodge of the Wellman Engineering Co. will summarize. This discussion is to be confined to steels used as received from the steel mills; the customer doing no heat treatment other than perhaps a stress relief. "The Inspection of Metals" discussion of Wednesday evening will be conducted by Dr. John W. W. Sullivan, Chief, Inspection Division, Cleveland Ordnance District. Lt.-Col. C. F. Davies, Office of Chief of Ordnance, Industrial Service, Production Section, will act as summarizer.

Thursday afternoon's meeting will deal with "Alloy Castings" (Steel and Iron). Co-chairmen are A. L. Boegehold of General Motors and C. H. Lorig, Battelle Memorial Institute. E. J. Hergenroether will represent the Conservation and Substitution Committee. Mr. Lorig will summarize. The second portion of the Thursday afternoon session will be directed by Dr. O. E. Harder, assistant director, Battelle Memorial Institute and president of the American Society for Metals. A. Allan Bates, manager, chemical and metallurgical department, Westinghouse Electric & Mfg. Co., will be the summarizer. Slated for discussion are the replacing of tin-base babbitts by lead-base babbitts, substitutes for bronze bushing and bearings, problems and substitutes in powder metallurgy bearings, cadmium-base bearings, silver bearings, bearing substitutes in the automotive industry, problems in aircraft bearings and the use of the iron-copper bearings.

Friday's afternoon session will deal with "Molybdenum High Speed Steels and Tool Steels." Dr. Bradley Stoughton, Chief of Tool Section, Office of Production Management and president-elect of the American Society for Metals, will lead the discussion. G. V. Luerssen of the Carpenter Steel Co. will summarize.

The Wire Association's portion of the National Metal Congress and Exposition will be highlighted by a special luncheon entitled "National Unity and National Defense." The luncheon will be held Monday, Oct. 20, and will present four men prominently identified with national defense activities. Dr. A. A. Stock-

(*Turn to page* 54, *please*)

Making the Borg & Beck F

WITH the interest of the entire industry focussed upon new transmission and clutch arrangements and automaticity of transmission changes, we are glad to present a brief description of the manufacture of the Borg & Beck fluid coupling which is to be featured as optional equipment on at least several makes of cars for 1942. Design details of this unit were given in AUTOMOTIVE INDUSTRIES, July 1, 1941.

The fluid coupling department is a self-contained operation, occupying a large bay in the Borg & Beck clutch plant in Chicago. It has been equipped and laid out for the production of about 200 units per day. Since the major stampings for the coupling are made in another plant, the Chicago operation is concerned, primarily, with the machining of parts such as the rotor sleeve and the front mounting flange; also with the many assembly and sub-assembly operations, welding, flame-hardening, balancing, and testing.

It may be noted that various sub-assembly and assembly operations have presented some unusual problems which have been solved in ingenious ways as will be evident by a study of the production set-up to be described in this article.

Examination of the drawing of the unit will show that the assembly has a number of welded joints which must be oil-tight and free from leaks. These joints are made by arc welding in automatic machines made by The Lincoln Electric Co., utilizing the well-known electronic tornado principle with the shielded carbon arc. One of the most spectacular of these operations is the seam-welding of the joint between the front and rear housings to encase the entire assembly, producing a strong and leak-proof joint.

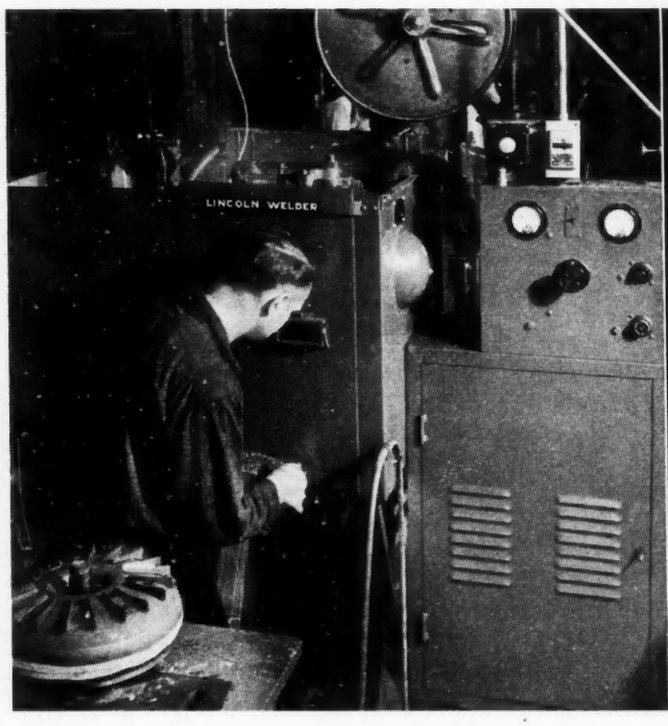
Among the other unusual operations found in the assembly department are — the lapping of the seal elements to surface flatness compatible with optical flats, rapid sub-assembly operations, the flame hardening of the rotor sleeve seal surface, and many others.

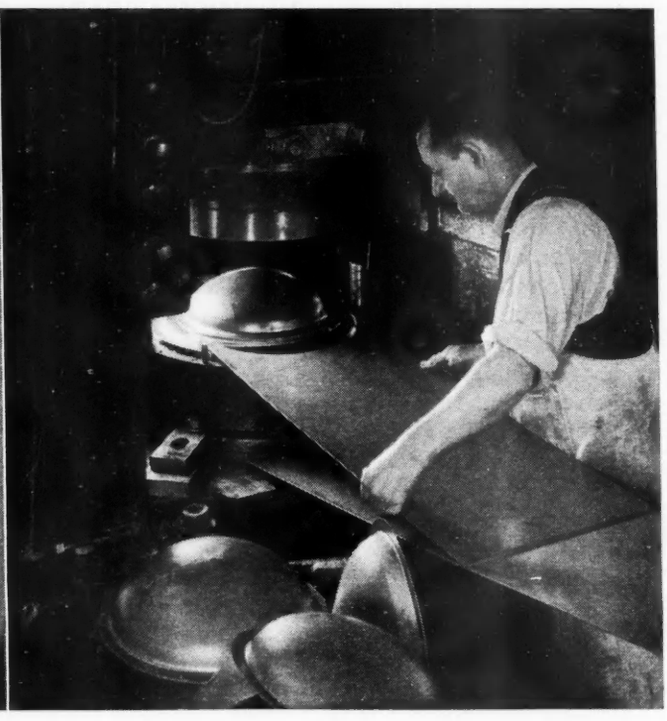
Perhaps the best way to visualize the various stages of assembly of the coupling is by reference to the drawing reproduced here. Let us examine, first, the major elements of the unit as outlined below:

1. The rotor (A), stamped from 5/64 in. steel

(Left) The assembly is hermetically sealed by seam-welding the joint between the front and rear housings on this Lincoln Welder. This machine is one of the two Electronic Tornado automatic arc-welding machines supplied by The Lincoln Electric Co.

(Below) First forming operation on the front housing. This is done in the Wisconsin Metal Products Plant





Fluid Coupling

One of the Federal resistance welding machines in this department. This operation—the welding on of ten cooling vanes — is done with a unique sliding fixture. One position of the fixture takes the inner row of spot welds the second position takes the outer row of spot welds

stock, whose principal feature is the punching of 27 radial slots, spaced equally around the outer periphery and at the center, to accommodate the blades. The width of these slots is held to 0.057 plus or minus 0.002 in., a rather fussy operation for punch press work. These slots are produced in three separate operations in an indexing die which takes nine slots at a time.

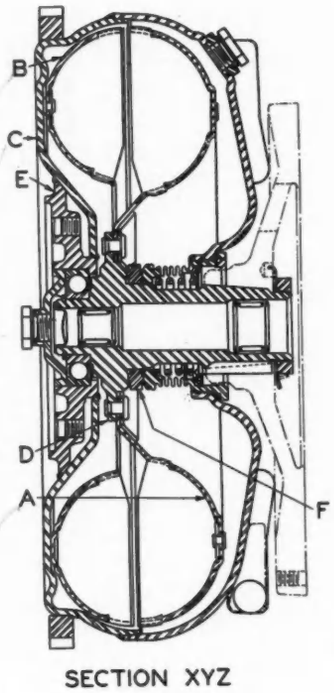
2. The impeller (B) stamping is made of 5/64 in. stock, and has 24 equally spaced radial slots, produced in three settings with an indexing die taking eight slots at a time. It is of interest to note that the annular flat portion for the vanes is held parallel with the outer edge of both the impeller and rotor within an indicator reading of 0.006 in.

3. The front housing (C) is drawn from SAE 1010 hot rolled extra deep drawing stock, normalized. This stamping has a number of fussy operations, including a flat surface section on the outer inclined dished portion to provide a good seat for the mounting flange weld.

4. The rotor and impeller vanes are punched from SAE 1010 hot rolled stock, the stock being held to a thickness of 0.062 in. plus or minus 0.005 in. A feature of the vanes is the coining of the small lugs which fit into the pierced slots at assembly. These lugs are held to a thickness of 0.058 in. plus or minus 0.001 in., the coining operation also producing a taper which leads the blade into the slots, thus facilitating the smooth pressing-in operation in the special assembly fixture.

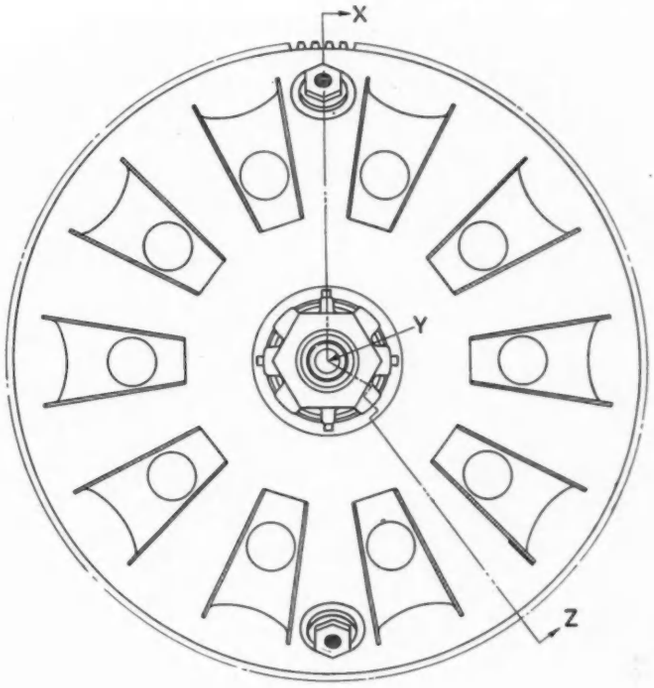
5. The machined rotor sleeve (D), the mounting flange (E), Morganite disk (F), cooling vanes, etc.

The assembly operations utilize a number of Federal resistance welding machines, a Surface Combustion normalizing furnace, a unique Hanna cold riveting machine, and two special automatic arc-welding machines made by The Lincoln Electric Co. Other pieces of special equipment comprise a



SECTION XYZ

Constructional details of Borg & Beck fluid coupling



four-head oxy-acetylene flame hardening machine, designed here and fitted with Linde Oxweld components; and an induction heating machine, designed here, for heating flywheel gears.

One of the principal sub-assemblies is that of the front housing and flange (C-E). As may be seen on the assembly drawing, the flange is welded to the stamping in two places—on the inside surface of the housing, and on the outer surface along the dished area. This welding job is done on the first of the two Lincoln welders, the parts being mounted on an automatically rotating fixture, the weld bead being produced automatically. Each weld is made separately, the work being turned over to take each side. Immediately upon completion of the welding, this assembly goes into the Surface Combustion furnace where it is held for an hour at a controlled temperature of 500-550 deg. Fahr., to relieve the strains.

Another major sub-assembly is the rotor and sleeve assembly. Let us first consider the sleeve. After machining, it goes to the flame-hardening machine where the inner seal surface, which is in contact with the Morganite disk, is hardened. In this operation, the sleeve is rotated automatically on an arbor while the four torches play on the surface to be hardened. The water spray comes in automatically at the proper time to quench the heated surface. Following this, the sleeves are placed in the furnace for normalizing, going through the standard cycle of one hour at 500-550 deg. Fahr. After heat treatment, the hardened surface is ground.

Then the sleeve is riveted to the rotor in the Hanna cold-riveting machine, taking two rivets at a time. Previously the blades have been pressed in and riveted in place. Following these operations, the sub-assembly goes through the normalizing furnace. Subsequently, the flame hardened and ground surface of the rotor sleeve is precision-honed in a special machine using 400 grit stones for roughing and 600 grit for finishing.

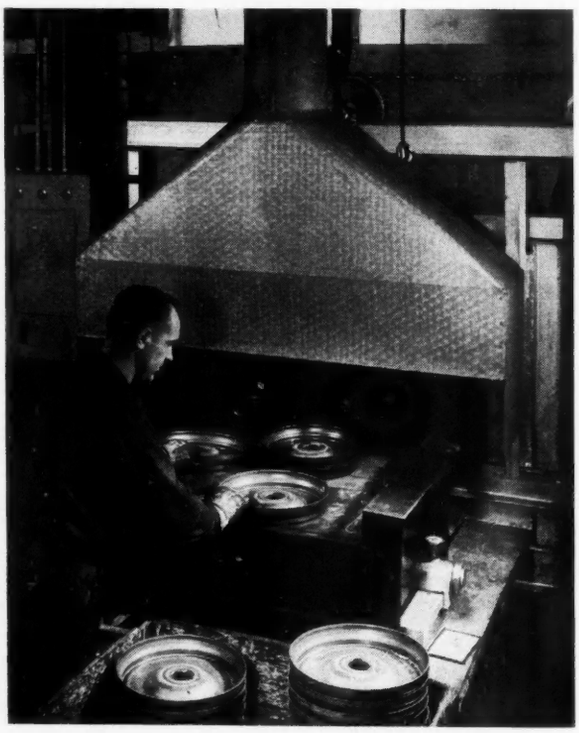
The impeller is fitted with its blades in an assembly fixture, then the blades are riveted in place. The impeller assembly then is welded to the front housing with 12 spot welds in one of the Federal resistance welding machines. This machine is provided with two different sets of fixtures. One of these is used for the operation mentioned above; the other for welding the ten cooling vanes on the rear housing. The latter fixture is slidable, takes the inner set of welds first, then moves outward to take the outer set of weld spots, thus making two welds for each vane.

A big 250 KVA Federal welder is employed for welding the two filler plugs on the rear housing.

Assembly of the front and rear housings is handled at this station. The large gas burner at the left is used to heat the rear housing, providing the expansion for the shrink fit at the joint. Then the two sections are pressed together and water-quenched in the fixture shown at the right

Before the final assembly, each of the sub-assemblies —the rotor and the impeller—is balanced on a GMR balancing machine, correction for balance being achieved by welding small disks, using an especially small Federal gun welder for this purpose.

An interesting control operation is found in the testing machine which checks the



Loading end of the Surface Combustion normalizing furnace, used for normalizing and strain-relieving operations on many components. The temperature of the furnace is held between 500 and 550 deg. F.

One of the most unique and exacting of the operations performed on the rotor and impeller stampings is that of punching the holes and piercing the radial slots for the blades. This is done in the Wisconsin Metal Products plant, employing a special indexing die which takes eight or nine slots at a time, finishing the group of 24 or 27 slots in three settings

strength of the spot welder fastening the impeller assembly to the front housing. The sub-assembly is placed in the fixture, then the checking head is brought down in engagement with the blades. While in this position, the head is turned by a torque arm which applies a standard loading designed to load the blades to over ten times the amount of loading encountered in actual service. This assures the strength of impeller welds for the life of the unit.

We mentioned earlier, the arrangement for induction heating of the ring gear. This is done to expand the ring for assembly onto the front housing. Following this operation, the ring is tack welded in three places, equally spaced, providing a bead at least ½ in. in length at each section.

The final assembly of the fluid coupling, after all of the sub-assembly operations have been completed, marks a departure in the usual practice. For this operation the rear housing is placed on a special gas burner and heated until it has expanded sufficiently to make up for the interference fit between the front and rear housing joint. Then the two halves are brought together, in a fixture, and seam-welded together in the Lincoln Electric arc-welding machine. In this machine, the unit is mounted on an automatically revolving arbor and the oil-tight weld bead is laid on automatically.

It will be noted from an examination of the assembly drawing that the unit has a number of joints which must be entirely free from oil leaks under conditions of high temperature and pressure. Among such points is the inner weld between the flange and the front housing; the peripheral seam weld; and at the oil seal.

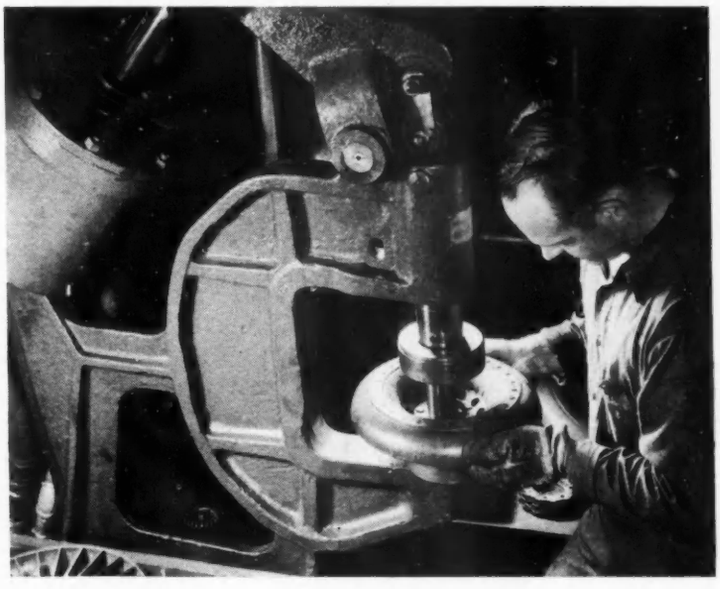
With respect to the oil seal, the major sealing effect is required at the rubber surfaces between the Morganite disk and the rotor sleeve, at the front, and with the end bearing surface of the Sylphon seal at the rear end of the disk. It was noted earlier that the rotor sleeve has a hardened and finely lapped contacting surface. The contacting end of the Sylphon assembly is flame-hardened, ground and lapped.

The lapped contacting surface is then checked for flatness with optical flats, using a sodium tube light source to increase the accuracy of the reading. Flatness is held to a limit of two wave-lengths.

The Morganite disk, therefore, must be finished to extremely close limits, fine surface finish, and flatness so as to bear perfectly on both sides. The preciseness of flatness is so imperative that special means have been taken to check the disks before they are approved for assembly. For this purpose, the inspection department has built a special test fixture in which each side of the disk is checked for flatness by fitting it on a standard flat plate and then measuring the leakage by applying a measured vacuum. Readings are taken on a manometer. This instrument is quite delicate and is handled by an inspector in a special booth.

Finally it may be noted that all of the critical joints are tested for leaks and must be free from leaks at an air pressure of 25 lb.

When the entire assembly has been completed, it is checked for dynamic balance, the balance being corrected to within 0.4 oz.-in. by welding small disks onto the vanes.



Hanna squeezer cold-rivets the rotor sleeve to the rotor stamping, taking two rivets at a time

MEN and

USUALLY it is not necessary to anneal after flame cutting. However, with some types of steel, occasionally in the case of plates and in some other situations, annealing is desirable. Recently Joseph T. Ryerson & Son, Inc., Chicago, installed an annealing furnace to handle their stock steel products after they have been flame cut.

Though 24 ft. long, the furnace can be divided into three sections as shown by the accompanying photograph. Each of the three furnaces may be used as a separate unit, making possible an exceptionally prompt annealing service. The furnace, especially designed by Ryerson engineers, has a structural steel framework and is lined with a special heat resisting material. It is crane-served and so situated that steel to be annealed can be quickly transported to the furnace, which is gas fired and has "finger-tip" equipment for temperature and timing control.

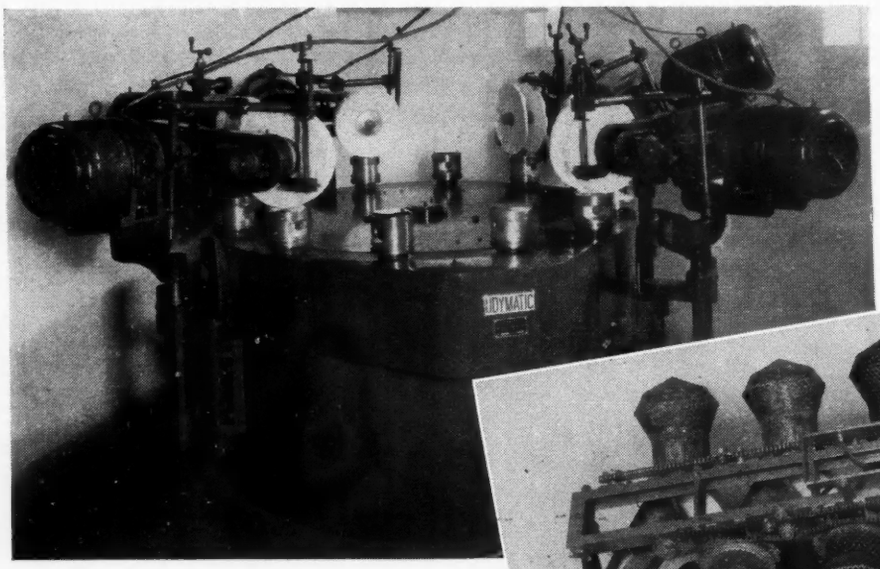
THE UDYLITE Corp., Detroit, manufacturers of electroplating and polishing equipment, announces the development of an automatic polishing machine for buffing aluminum aircraft engine pistons. The machine, shown in the illustration, buffs the sides and top in 15 seconds, the company states, as against 10 minutes by hand on a manually operated buffing lathe.

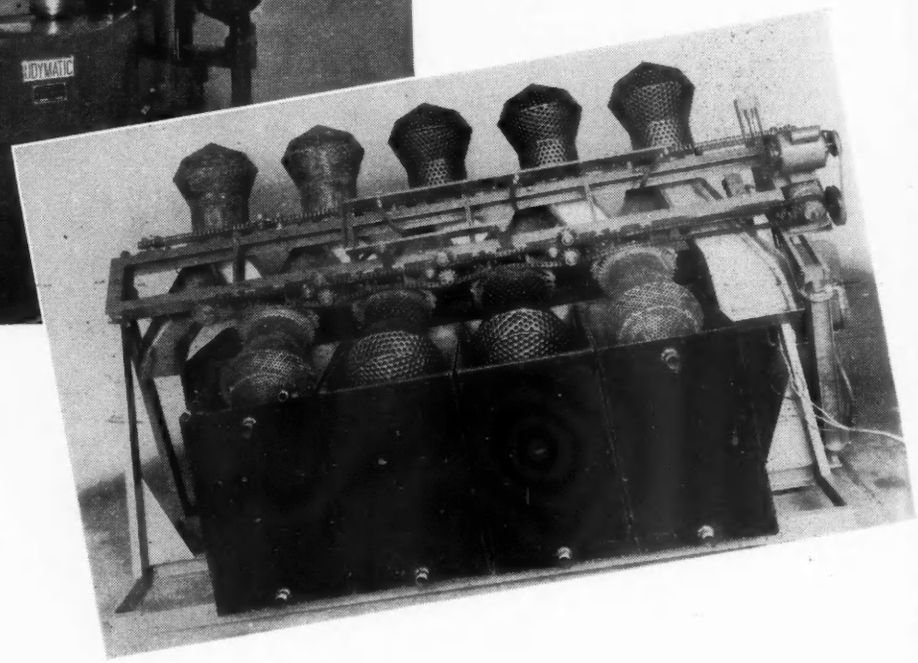
The machine consists of an automatic index table and twelve chucks to hold the pistons, which rotate during the buffing operation. The chucks are stationary during the indexing period and during the loading and unloading. Six buffing pedestals are arranged around the machine to accommodate the buffing wheels, driven through a "V" belt drive. Buffing pressure is adjustable by means of a tension spring. The wheels may be adjusted to any angle desired.

Another Udylite development is a full automatic barrel cleaning and plating machine for handling small parts in bulk. It is completely automatic in that the parts are subjected progressively to the various cleaning, rinsing, pickling, plating and drying operations without manual handling. In several installations these machines are being used to zinc and cadmium plate aircraft engine parts, zinc plate machine gun chips and pickling operations on brass cartridge shells.

A NEW product of the Industrial Sheet Metal Works, Detroit, is the Hydro-Whirl dust collector, which was designed especially for removing the hazards in connection with the processing of magnesium and its alloys. The Hydro-Whirl uses an entirely new principle in wet dust collecting and is effective on all types of metal dust, not only magnesium but also aluminum, iron, steel, and others as well. The working mechanism consists of a rotating shaft on which are centered a series of discs. The controlled rotating speed of the shaft in a horizontal plane throws a rain of water into the baffled section of the unit, at which point the dust is whirled out of the air stream into a tank. Scientific calculations have attained a proper balance between the velocities of air and water. This balance is said to insure thoroughly cleaned air, which may be returned to the building.

BY INSTALLING motorized sealers for Scotch tape, the Thompson Products Company, of Cleveland, can now





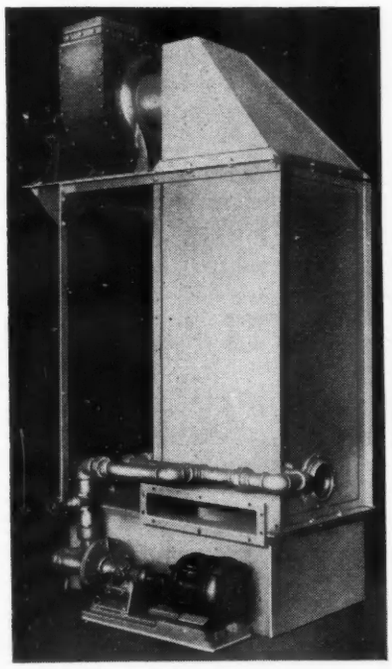
(Above) Udylite automatic polishing machine for buffing aluminum aircraft engine pistons.

(Right) Full automatic barrel plating machine, built by Udylite, handles small parts in bulk.

MACHINES

seal five times as many boxes as formerly. Until recently one girl sealed nine boxes per minute. One Scotch tape motorized Sealer stepped up production to 25 boxes per minute for one girl, including packing in a hand truck. Using a dual set of these sealers, as shown here, this was further speeded to 45 boxes per minute for one girl with each box sealed in two places.

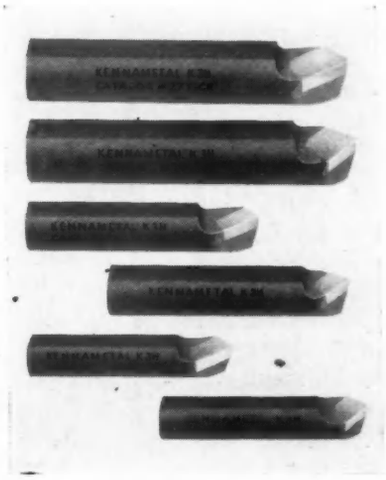
This new box sealer, sold by Minnesota Mining and Mfg. Co., St. Paul, Minn., automatically cuts and applies a uniform length of Scotch tape as the boxes are passed over two rollers. It was developed especially to speed production of companies packaging their products in telescope type boxes.



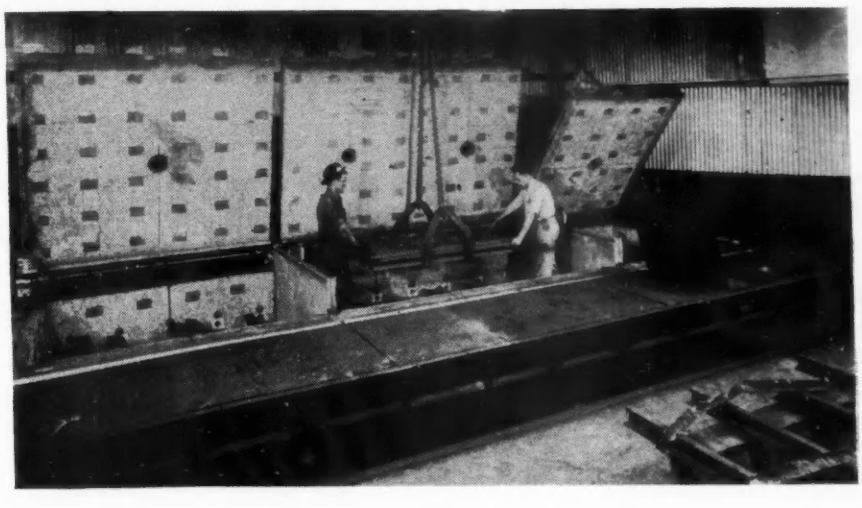
A NEW series of standard Kennametal boring tools with round shanks, to be known as Styles 27-R and 29-R, has just been announced by McKenna Metals Company, Latrobe, Pa. These new Kennametal tools have the same tool angles as other standard Kennametal boring tools, a feature of which is the 12-deg. positive back rake to compensate for the negative effect of the tool being held at height one-half the height of the shank above center. Style 27-R tool is for use in 30 deg. boring bars, and Style 29-R tool is for use in 45 deg. boring bars. They are supplied in common shank sizes, the tolerance on the round shanks being plus .000 in. minus .001 in.

Styles 27-R and 29-R Kennametal tools are tipped either with Kennametal grade KM, the most widely used grade for machining steel, or with Kennametal grade K3H, the very hard grade used for precision boring and finishing cuts of all types.

(*Turn to page* 52, *please*)



Various sizes of Styles 27-R and 29-R Kennametal boring tools. Style 27-R tool is shown at the top of each group.



(Above) Minnesota motorized sealer steps up packaging production.

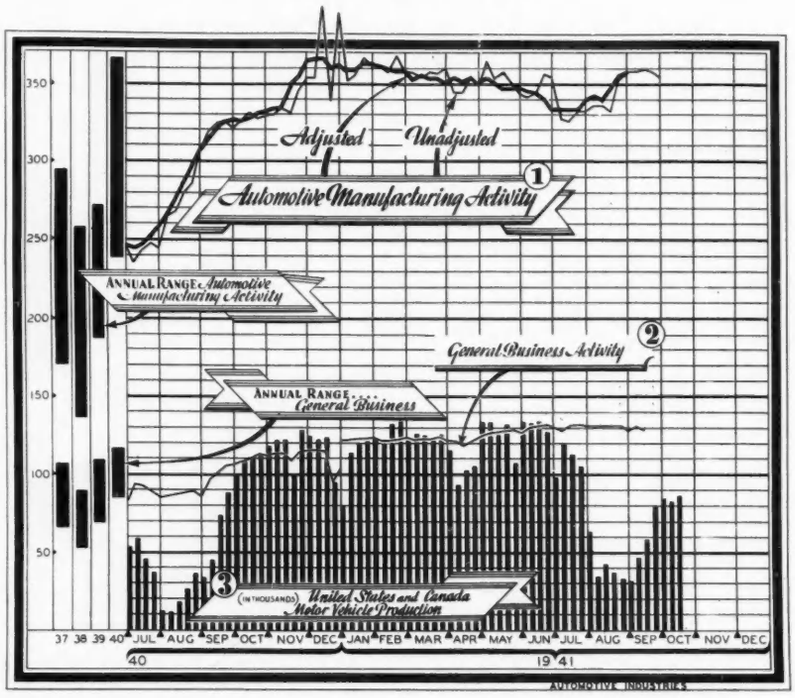
(Above right) Hydro-Whirl dust collector built by Industrial Sheet Metal Works.

(Right) Lowering plates into the new annealing furnace recently installed in the Chicago plant of Joseph T. Ryerson & Son, Inc.

WHAT THE INDUSTRY IS DOING

[*Our own view of automotive production and sales; authoritative interpretation of general conditions*]

Production Levels Off To Restricted Quotas



Weekly Indexes of Automotive General Business

PRODUCTION in the automotive industry leveled off at the rates dictated by the OPM curtailment program as mid-October was reached. Output for the first half of October was estimated at 183,500 units. As the month has 23 working days, the October total is expected to exceed 360,000 units despite curtailment, which would make it the largest total for the month, with the exception of 1940, since 1929. This compares with 254,600 units produced in September, according to the AMA, a drop of 11 per cent from the same month of 1940, but bigger than any September for 12 years.

Passenger car output in the U. S. for August and September is estimated at 280,000 units, leaving a total of approximately 537,000 passenger cars to be turned out in October and November. This average of 268,500 passenger cars per month for the latter 2 months under the quota restrictions compares with a December quota of 204,848 passenger cars, when the 48.4 per cent cut in production takes effect. However, there is a possibility that some manufacturers may not be able to make their full quotas due to shortages of critical materials such as copper and steel resulting from defense priorities.

Production for the week ending Oct. 11 was estimated at 82,200 units. General Motors divisions, most of them operating at their quota peaks, accounted for 37,900 units, while Chrysler produced 16,600, with Dodge and Plymouth in full production after work interruptions the week before due to body shortages. Ford, which assembled more than one-third its four-month quota in August, manufactured 15,400. Nash topped the independents, followed by Hudson, Packard, Studebaker and Willys. Studebaker's passenger car line closed down due to a shortage of frames resulting from a strike at the plant of a supplier. International Harvester also was closed by a strike at its Springfield plant.

Although it is a little early to gauge the entire picture accurately, it appears that some sales resistance is developing towards the 1942 models. This is attributed to several factors, especially that the 1941 models were oversold, possibly by more than 1,000,000 units, as purchasers rushed in to buy before higher prices, higher taxes and alternate materials went into effect. Price increases have ranged from 5 to 22 per cent on the 1942 models, while the federal excise tax was boosted from 3½ to 7 per cent on Oct. 1. These price boosts appear to be tacitly approved by the OPA.

Now that all the '42 models have been introduced and the buyers have had a chance to compare them and to learn that there has been no sacrifice in quality or performance, it is likely that sales will pick up. Another incentive to buy in the next few months may be the anticipated order by the OPM to ban much brightwork on new automobiles produced after about Jan. 1.

New passenger car registrations for September reflect lower sales. Reports from 113 principal cities for the first 22 days of September showed a 16 per cent drop compared to the same month of 1940, according to R. L. Polk & Co. Biggest decreases were in New England and the South. This compares with August new passenger car registrations of 246,595 units, a gain of 17 per cent over August, 1940, and the biggest for the month since 1937. For the first eight months of 1941, new passenger car registrations totaled 3,105,671 units, an advance of 33 per cent over the same period of 1940. New passenger car inventories had declined to 17,393 units as of Sept. 1.

[1] 1923 average = 100; [2] Prepared by Administrative and Research Corp. of New York to Jan. 1, 1941, and *New York Times* weekly business index after that date; [3] Estimated at the Detroit office of AUTOMOTIVE INDUSTRIES.

Arms Contracts Increase As Production Speeds Up

Plane Parts Production Outgrowing Experimental Stage as Plants Settle Down to Capacity Output

The Murray Corp. of America will begin shipment of inboard wing assemblies this month on an $18,000,000 order from Douglas Aircraft Co., Inc. Murray's national defense orders for airframe subassemblies and military truck frames total nearly $50,000,000. The Douglas contract, which was received last February, calls for parts for Douglas A-20B attack bombers.

Murray also is undergoing tooling preparations for the production of outer wing assemblies and the four engine nacelles for Boeing B-17E bombers. This order, covered by letters of intent, is for $27,000,000. Deliveries will not start until early 1942. Murray had approximately 3000 workers on defense jobs in September, about 40 per cent of the total employes, but this is expected to rise sharply and may reach 10,000 men during full production.

Increased use of diesel engines in tanks is foreseen in the building of a $2,411,000 plant at Dallas, Tex., by the Guiberson Diesel Engine Co. This plant will turn out air-cooled radial type diesel engines for use in M-3 28-ton tanks, delivering 400 hp. to drive them 25 m.p.h. This diesel engine gives a tank twice the cruising radius of a gasoline-powered tank on the same amount of fuel.

General Motors contracts for machine guns were increased to $136,000,000 with the award of new orders for Browning .50-val. machine guns totaling $14,175,203 to Frigidaire Division, Dayton, Ohio, and $12,834,173 to AC Spark Plug Division, Flint. AC achieved its daily production goal on these guns in September just one year from the day when the original contract was received. The first gun was completed in March and the 1000th gun was delivered in July, 10 months ahead of schedule. The plant eploys 2800 workers.

Saginaw Steering Gear Division, which also has a share of the GM machine gun orders, has received an Army contract to manufacture .37-mm. armor piercing ammunition.

Ford has received two large defense orders, one for $231,741,500 for Consolidated B-24 bombers and spare parts to be produced in the new Willow Run plant now under construction, and another for $182,955,559 for Pratt & Whitney radial aircraft engines to be manufactured in the new plant at the Rouge. The latter order boosts Ford aircraft engine orders to more than $444,000,000.

Ford engineers already have moved into the partly completed Willow Run plant and are installing machinery preparatory to turning out bomber parts by the end of October. Preliminary tests of welded sections of the B-24 bomber have been completed by Ford and the Air Corps has given tentative approval to eliminating two-thirds of the rivets in favor of welding.

Secretary of the Navy Frank Knox will come to Detroit Oct. 28 to dedicate the new Hudson Naval Arsenal. This arsenal, comprising 14 buildings containing more than 1,000,000 sq. ft., will augment and duplicate the facilities of the naval gun factory at Washington.

New Defense Plant Corp. awards include $37,161,530 to Chevrolet for building and equipping plants at Buffalo and North Tonawanda, N. Y., for the production of Pratt & Whitney aircraft engines. Aeroproducts Division of GM has been granted $11,453,128 for machinery to make propellers at Dayton, Ohio. Allis-Chalmers Mfg. Co.,

(*Turn to page* 47, *please*)

History Repeats

There's an old saying that history repeats itself. I have proof of that in a bulletin issued by the National Automobile Chamber of Commerce to its members under date of August 1, 1917.

The bulletin contained a list of "Don'ts."

The first one said: "Don't call it a pleasure car. Call it a passenger car or automobile."

Down at the bottom of the page, the last one said: "Don't take too seriously the talk about failure of the supply of gasoline."

Now here we are in 1941. Despite that solemn resolution of 1917 against the expression "pleasure" car, I saw it recently in two New York newspapers. I have heard it used repeatedly during the last few months by Government officials in Washington.

From address of Paul G. Hoffman, Studebaker president and AMA vice president, at annual meeting of American Association of State Highway Officials in Detroit.

Thomas J. Lítle, Jr.

Thomas J. Lítle, Jr., director of engineering for Bendix Home Appliances, Inc., died Oct. 6 at his home in South Bend, Ind. He was president of the SAE in 1926. Litle joined the Cadillac Motor Car Co. as an engineer in 1917 and later was chief engineer of the Lincoln Division of Ford Motor Co.

Army Liaison Plane

For observation and direction of troop movements from the air, several small liaison airplanes of similar design are being tested by the Army Air Corps at Wright Field, Ohio, including the plane shown here, which was built by the Taylorcraft Aviation Corp., Alliance, Ohio. Contracts totalling $37,205 have been awarded to the Aeronca Aircraft Corp., Middletown, Ohio; the Piper Aircraft Corp., Lockhaven, Pa.; and the Taylorcraft company. Taylorcraft will build the YO-57, Aeronca the YO-58 and Piper the YO-59.

The three models are strut-braced high wing monoplanes and are powered by Continental's four-cylinder 65 hp. engine. Each has two-way radio equipment.

The Air Corps also has under test the XTG-1 and XTG-2, two-place training gliders equipped with standard flight and navigation instruments. The XTG-1, manufactured by the Frankfort Sailplane Co., Joliet, Ill., has a wing span of 46 ft. and its length is 24 ft. The Schweizer Aircraft Corp., Elmira, N. Y., builds the XTG-2, which has a wing span of 52 ft. and a length of 25 ft. The gross weight of the former is 790 lb. and the latter 860 lb.

New Tank Schedule Spurs Greater Steel Plate Output

Automotive Consumers Likely to Have Increasing Difficulty in Obtaining Deliveries; Copper Supply Is Pressing Problem

By W. C. Hirsch

Stepping up of the tank production program to its goal of 3000 units a month in 1942 and as an aid in bridging the transition from employment on civilian to defense products has given plates a pivotal position in the finished steel roster. The Office of Production Management estimates present demand for plates at the rate of 8,500,000 to 9,000,000 tons per year and present production at the rate of 6,300,000 tons per year, leaving a gap of approximately 2,000,000 tons a year. One-third of this deficiency is being met by the making-over of strip mills for plate rolling and the remaining two-thirds by additions to plate rolling capacity, both remedial steps being now in progress.

At present nearly all of the steel plates are needed for manufacturing tanks or equally vital defense material. Pending greater relief as additional capacity becomes available, this tight situation is being met by giving the right of way to the most urgent needs over only ordinarily urgent needs since it is impossible to differentiate between these two classes by means of priority ratings. That steel mill executives no less so than OPM officials have a tough job on their hands to satisfy all manufacturers holding defense contracts, to say nothing of others, is obvious. It is, therefore, doubly gratifying that more and more expressions of commendation are coming from those directly affected regarding progress in the equitable distribution of this or that priority item.

General satisfaction, for instance, was voiced with the October allocation of available pig iron supplies, systematization of which under the mandatory priorities system coming in for wide approval. Diminution by the defense program of capacity for the rolling of heavy hot rolled sheets has also caused abatement in the demand for cold rolled sheets from automobile manufacturers. It is only natural that when material for frames is difficult to obtain, purchasing of panel and fender stock slows down. Some steel producers are of the opinion that automotive consumers will encounter more and more difficulty in obtaining adequate steel supplies even for their sharply curtailed production schedules.

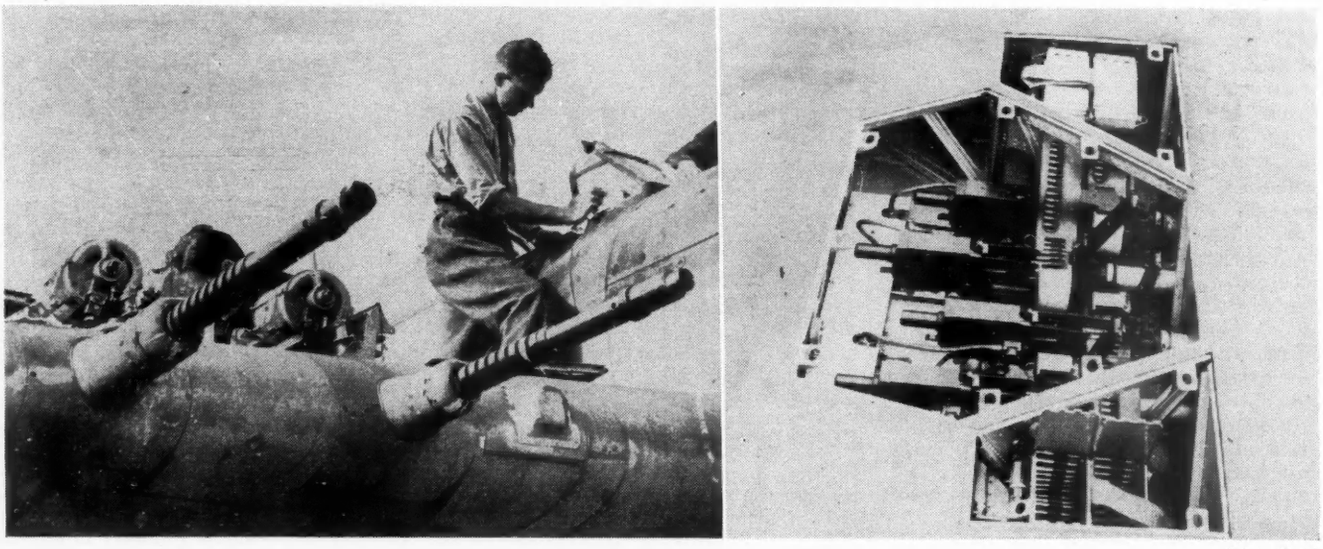
The reaction of the steel industry to the Office of Production Management plan for 10,000,000 tons expansion in the nation's annual steel making capacity differs little from that which followed the recommendations contained in the Gano Dunn reports and recommendations. Walter S. Tower, president of the American Iron & Steel Institute, stated in a recent speech that talk of the need to expand steel capacity had contributed greatly toward excessive forward buying and helped to make matters worse concerning the delivery of steel. Mr. Tower said that annual steel capacity was being expanded this year by 4,000,000 tons and that the total might top 89,000,000 tons or 22,000,000 tons above the 1940 output.

The supply of copper is becoming increasingly more of a problem for consumers. Supplies from South America are not up to expectations and extension of domestic production, still largely in the planning stage, is not likely to yield much relief before the latter part of next year or 1943. Control of scrap supplies is being tightened, but all of this fails to remedy the constantly increasing number of delays in brass shipments.

Reports of tin purchases by the British government from its nationals in the East to apply to Lend-Lease obligations in the United States are declared to be without foundation in fact. Malay tin interests are agitating for abolition of export duties to enable them to compete in the United States market, once production in American smelters from Bolivian ores becomes an actuality.

Canada's Aircraft Order

More than 7000 aircraft are on order for Canada at the present time, according to C. D. Howe, Minister of Munitions and Supply. Most of these are to be built in Canada. "We are building 13 different types of aircraft," he stated, "but hope, however, ultimately to narrow these down to six or seven." The smaller group probably will include elementary trainer, single engine advance trainer, twin-engine advance trainer, coastal reconnaissance amphibian, bomber, and fighter types. Twenty-nine plants scattered from Halifax to Vancouver handle the overhaul and repair work.



International

Hurricane II Has More Stingers

Here are two closeup views of the new Hurricane II, the fighter plane which the Britain's R.A.F. recently introduced as an improvement over the Hurricane I. These new warplanes are equipped with the latest Rolls Royce Merlin engine, but most important their armament has been increased considerably. One group is fitted with 12 machine guns each and the other with four 20-mm. cannon mounted in the leading edge of the wing. At the left is shown two of these powerful cannon. At right is a rare picture made from the cockpit and showing the machine gun mechanism in the wing.

MEN . . . . . .

W. F. Kurfess, vice-president of Joseph T. Ryerson & Son, Inc., has been ordered to active duty in the U. S. Navy. He will be in charge of the Steel Division of the Bureau of Ships.

C. E. Weaver has been named manager of Globe Hoist Company's Industrial Division. He will manage engineering and sales of hydraulic and mechanical lifts and elevators at both the Philadelphia and Des Moines plants.

Wallace W. Lockwood has been appointed advertising manager of Taylor Instrument Companies, Rochester, N. Y., to succeed Elmer E. Way, resigned.

R. H. McCormick has been put in charge of all advertising and sales promotion of Vascoloy-Ramet Corp.

James W. Parker, vice-president and chief engineer of the Detroit Edison Co., was elected president of The American Society of Mechanical Engineers for the current year.

Grove Webster, Director of the Civilian Pilot Training Service since its inception in 1938, has resigned to re-enter private aviation. Mr. Webster will be succeeded by **Major John P. Morris,** Air Force Reserve, who has been Assistant Director. **W. G. Stewart,** Chief of the CAA pilot training performance division, will fill the post vacated by Major Morris.

Chas. H. Dolan, former vice-president of operations of Eastern Air Transport, Inc., has been appointed general manager of the newly-formed Aviation Division of Chicago Pneumatic Tool Co.

Joseph Geschelin, Detroit Technical Editor, Chilton Publications, is on call as automotive consultant to the Division of Civilian Supply, OPM. Mr. Geschelin recently was nominated for SAE vice-president in charge of production engineering.

Lynn Snow, Oak Park, Ill., regional vice-president of the National Automobile Dealers Association, has been appointed chairman of the organization's 25th annual convention which will be held in Chicago, January 19-22.

J. E. Johnson, vice-president and general manager of the Muskegon Division of Muskegon Piston Ring Co., has retired, but he remains a member of the board of directors. **G. W. Lundeen,** treasurer, has been named general manager of the division, while **M. D. Stanley** becomes assistant manager.

Three new members have been elected to the board of directors of the Autocar Co. **John A. Payne,** president of Consolidated Coppermines, Inc.; **Robert Simon,** president of Liberty Aircraft Products Corp., and **Oliver H. Payne,** attorney, fill vacancies created by the resignation of Walter S. Mack, Jr., Edward A. LeRoy, Jr., and C. A. Colpitts.

Louis B. Neumiller, formerly vice-president, has been elected president of Caterpillar Tractor Co., succeeding **B. C. Heacock,** who becomes chairman of the executive committee. Mr. Heacock is on leave of absence serving as special assistant to Undersecretary of War Robert Patterson. R. C. Force resigned as chairman of the executive committee, but remains a member of the board of directors. **D. G. Sherwin** has resigned as a director.

Leslie A. Baldwin has been elected vice-president of Johns-Manville Corp. in charge of sales of industrial products.

James S. Knowlson, president and board chairman of Stewart-Warner Corp., has been appointed deputy director of priorities in charge of operations by OPM.

J. M. Hutton, Jr., has resigned from the board of directors of Sparks-Withington Co. and the board membership has been cut to 10 members.

Fruehauf Trailer Co. has announced the following changes in its executive personnel: **Harry R. Fruehauf** becomes first vice-president; **Roy A. Fruehalf,** vice-president in charge of operations; **Lester C. Allman,** executive committee member; **Arthur L. Struble,** vice-president and director of sales; **Robert Kirksey,** vice-president of the parent company; **Roy Warren,** director of purchases; and **John Votypka,** director of engineering.

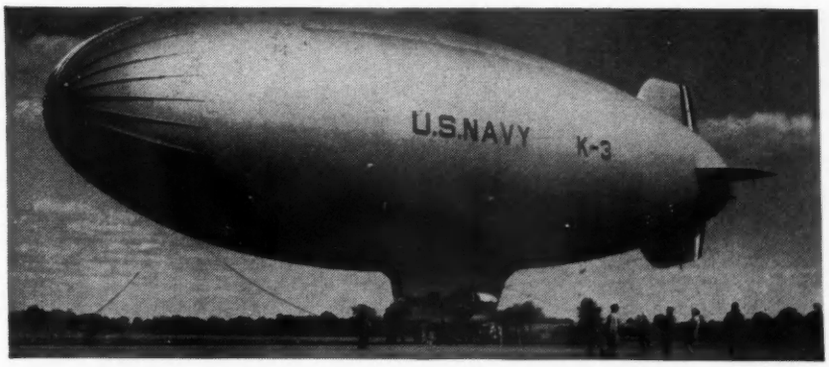
William C. Bray, manager of store administration for B. F. Goodrich Co., has been appointed general sales manager for Ferguson-Sherman Mfg. Co.

William A. Thompson has resigned as vice-president of Allis-Chalmers Mfg. Co.

Leslie B. Cooper, formerly associated with the Pitcairn-Larson Autogiro Corp., has joined Kellett Autogiro Corp. in connection with autogiro sales. **H. D. Guy,** who was superintendent of Vultee's Nashville branch, has been named factory manager at Kellett.

Ray P. Tennes, for the past seven years director and secretary-treasurer of Shafer Bearing Corp., has been elected chairman of the board of directors, succeeding his father, the late M. J. Tennes. He will continue as treasurer of the corporation. **W. L. Kinnaw,** comptroller, has been elected assistant treasurer-assistant secretary.

M. M. (Bob) Roberts, formerly merchandising manager of Hudson Motor Car Co., has taken over the post of advertising manager as well, succeeding **Herbert O. Ward,** resigned.



Wide World

New Eye for the Navy

This K-3, world's largest non-rigid airship and first of six observation units being built by Goodyear at Akron for the Navy, is shown as it returned recently from its maiden flight. The 246-ft. ship will be used for coastal patrol, mine searching and anti-submarine defense.

Samuel S. Norris

Samuel S. Norris, 79, treasurer of U. S. Rubber Co. from its founding in 1892 until his retirement in 1936, died Sept. 25 at Ridgefield, Conn.

Lee R. Miller

Lee R. Miller, 64, co-founder of the old Miller Rubber Co., died Sept. 27 at Akron, Ohio. He was associated with B. F. Goodrich Co. at the time of his death.

CALENDAR

Conventions and Meetings

Amer. Society of Tool Engineers, Toronto, Canada .....Oct. 16-18
National Metal Congress and Exposition: Cooperating societies—American Society for Metals, Wire Association, American Welding Society, Institute of Metals and Iron and Steel Divisions of American Institute of Mining and Metallurgical Engineers, Philadelphia .....Oct. 20-24
SAE Natl. Fuels & Lubricants Mtg., Tulsa, Okla. .....Oct. 23-24
Society of Automotive Engineers, Aircraft Production Meeting, Los Angeles .....Oct. 30-Nov. 1
SAE West Coast Transportation Mtg., San Francisco .....Nov. 5-6
SAE Natl. Transportation & Maintenance Mtg., Cleveland.....Nov. 13-14
National Assoc. of Manufacturers, New York City .....Dec. 3-5
Natl. Automobile Dealers Assoc., Chicago .....Jan. 19-22

Change Stearman Name

Boeing officials have announced the change in the name of Stearman Aircraft Division of Boeing Airplane Co. to Wichita Division, Boeing Airplane Co. This plant at Wichita, Kan., is now participating in the production of Boeing four-engine bombers and training planes. J. E. Schaefer is vice-president and general manager of the Wichita Division.

Monthly Motor Vehicle Production

(U. S. and Canada)

	PASSENGER CARS		TRUCKS		TOTAL MOTOR VEHICLES	
	1941	1940	1941	1940	1941	1940
January	423,223	375,478	100,835	74,016	524,058	449,492
February	405,160	350,535	104,172	71,690	509,332	422,225
March	422,289	364,947	111,587	75,285	533,876	440,232
April	387,070	375,626	102,784	76,807	489,854	452,433
May	427,538	338,353	117,817	74,139	545,355	412,492
June	427,521	294,779	118,757	67,787	546,278	362,566
July	347,597	172,166	121,298	74,005	468,895	246,171
August	81,689	48,333	83,103	41,533	164,792	89,866
Total, 8 Months	2,972,087	2,320,215	860,353	555,262	3,782,440	2,875,477
Year Total		3,802,454		889,884		4,692,338

International

Russian Trackless Tank

That trackless tanks are a part of the Russian mechanized equipment is indicated by this picture, which shows a German soldier advancing toward the tank after it was stopped by the first salvo. He holds a hand grenade and is about to hurl it at a vulnerable section to continue its demolition.

Automotive Production Cut Stirs Labor Unrest

Prospective Unemployment of 100,000 in Michigan by December; GM-UAW Agreement to Halt Migrations

Prospective unemployment of more than 100,000 workers in Michigan automotive plants is reflected in the labor unrest that has been evident in several companies that face large layoffs when the 48.4 per cent cut in passenger car production is felt in December. Slowing up of production at the Ford Motor Co. by workers who wanted to make their jobs last as long as possible finally resulted in a conference between Harry Bennett, Ford personnel chief, and UAW-CIO officials. Union officials agreed that the current working force, which numbers about 86,000 employes at the Rouge plant was capable of turning out 4125 engines per day.

After the company threatened to lay off 20,000 men, the union arranged a conference and agreed to try to convince employes that nothing would be gained by slowdowns. If Ford output falls short of the four-month quota of 146,745 Ford and Mercury passenger cars ending Nov. 30, that production is a dead loss and cannot be made up.

In a compromise move, the company laid off 300 probationary workers and 2400 non-production employes. However, according to the report to the Tolan Committee last month, Ford nondefense employment will drop from 70,139 workers in October to 49,892 in November, a reduction of 29,247 men, of whom only 2200 will be absorbed by Ford defense work. The Ford contract provides for cutting the work week from 40 to 32 hours rather than lay off any workers with six months' seniority.

Layoffs due to production curtailment resulted in several wildcat strikes at the Briggs Mfg. Co. during early October. Transfer of men with seniority to other departments with accompanying dismissals brought work stoppages that eventually shut the entire Briggs plant, putting 10,000 Briggs workers and 8000 Plymouth employes out of work. This culmination of 14 wildcat strikes within 60 days finally resulted in the dismissal of 15 employes responsible for the disruptions with the approval of union officials. Briggs Local 212 is under the direction of an administrator, Melvin Bishop, appointed by the UAW-CIO because the local officers were unable to maintain discipline.

In an effort to smooth the way for orderly transfer of workers from nondefense work, General Motors Corp. has signed an agreement with the UAW-CIO. The provisions of this agreement were similar to those drawn up by a joint meeting of manufacturers, union officials and OPM representatives held at Detroit in September. They are designed to expedite the defense program, maintain employe morale and reduce migration of workers.

ADVERTISING

Homer McKee has resigned as vice-president of Blackett-Sample-Hummert, Inc., to become associated with Roche, Williams & Cunnyngham, Inc. Mr. McKee headed his own agency for fourteen years and later was vice-president in charge of the Chicago office of Erwin Wasey & Co.

MacManus, John & Adams, Inc., Detroit, has been selected as public relations and advertising counsel for National Tool Co.

George W. Davis has been appointed a vice-president of Young & Rubicam, Inc. Mr. Davis joined the firm in 1937 and for more than a year has served as manager of its Detroit office and will continue in that capacity.

Bendix Aviation Corp. is sponsoring on Tuesday evenings the series of broadcasts of "The Treasury Hour—Millions for Defense." A new feature is the dramatic sketch, "The Invisible Crew," portraying American inventive industrial ingenuity working at top speed to equip the aircraft, tanks, trucks, cars, half-tracs and ships for defense.

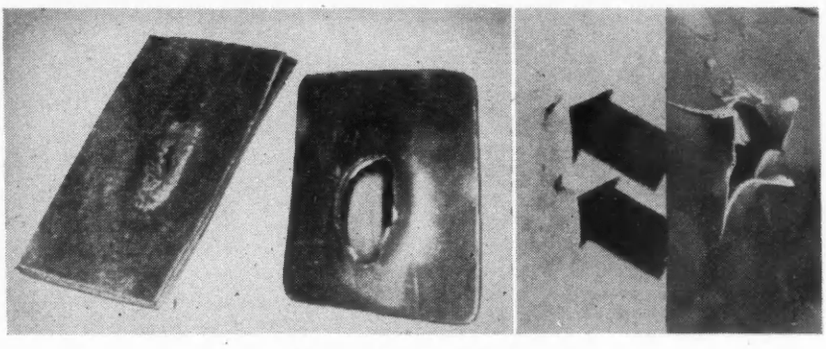
New German Fighter

According to news reaching England, the Germans are using a new fighter plane in Russia. It is the Messerschmitt Me-209, equipped with a Mercedes-Benz DB-603 engine of 1470 hp. The top speed is claimed to be 392 m.p.h. at 19,800 ft. Armament consists of four machine guns of 15 mm. in the wings and two 13 mm. machine guns in the cowling.

Parts Suppliers Plan Pooling Defense Work

In an effort to forestall unemployment in the plants of automotive parts suppliers, a plan is being developed under the direction of Frank Rising, general manager of the Automotive Parts & Equipment Manufacturers, Inc., to pool facilities among various manufacturers on national defense work. The first effort in the field will be among 120 plants that produce metal stampings.

Under this plan the plants must be pooled geographically in order to facilitate efficient production. York, Pa., pioneered in the community pooling plan.



New Materials for Industry

Known only as C-102, a new material one-third lighter than aluminum has been developed by U. S. Rubber. It resists ripping under gunfire more so than aluminum as above photo shows. (C-102 is on the left.)

Plioform is Goodyear's new substitute for aluminum fuel tanks for airplanes. It resists gunfire shattering better than aluminum, as shown above. It can be used for truck and automobile panels, too.

BOOKS . . . .

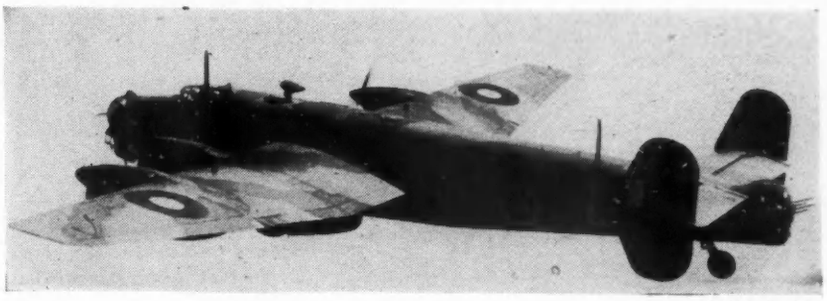
ENGINEERING ENCYCLOPEDIA, *in two volumes, edited by Franklin D. Jones and published by The Industrial Press, New York.*

This encyclopedia covers some 4500 subjects of interest in connection with mechanical-industrial activities. Individual subjects deal with various important mechanical laws, rules and principles; physical properties and compositions of a large variety of materials used in engineering practice; the characteristic features and functions of different types of machine tools and other classes of manufacturing equipment, and with numerous other subjects. These condensed treatises are accompanied by definitions of numerous trade and technical terms used in engineering and manufacturing practice.

The Engineering Encyclopedia is intended as a work of reference and should prove useful as such.

THE HIGH-SPEED COMPRESSION-IGNITION ENGINE, *by C. B. Dicksee. Published by Interscience Publishers, Inc., New York.*

Mr. Dicksee's book differs from most others on the same subject in that it does not contain any descriptions and illustrations of actual engines, but confines itself to a discussion of the principles governing the operation of these engines and of the problems associated therewith. The author has long been connected in an engineering capacity with the Associated Equipment Company, Ltd., leading manufacturers of compression-ignition engines in Great Britain, and therefore has an excellent background for such a task. His style is clear and concise, and the book is a very readable one. It confines itself mainly to the features which are special to the compression-ignition engine and does not deal in detail with the design of such parts as cylinders, pistons, valves, valve gear, etc. The following list of chapter heads will give a good idea of the scope of the work, which, it may be added, is an excellent typographical production: The Laws of Gases, The Idealized Cycles of Operation, The Chemistry of Combustion, The Losses and Limitations of the Practical Engine, The Air Charge Before the Admission of the Fuel, The Process of Combustion in the Compression-Ignition Engine, Air Movement in the Compression-Ignition Engine, Types of Combustion Chamber, Fuel Injection, Some Practical Results.



British Combine

Britain's Newest Bomber

The largest and fastest airplane ever built by Handley Page Ltd., the Halifax bomber recently was placed in production in Britain for the R.A.F. command. It is a mid-wing monoplane with twin fins and rudders. Its wing span is 99 ft. and length 70 ft. Power plant equipment includes constant speed full feathering propellers and four Rolls-Royce Merlin engines, the first time in many year that a British four-engine airplane has had liquid cooled engines. Note the multi-gun stinger turret beyond the tail.

Argentina Lifts Quota Restrictions on Autos

Quota restrictions on the importation of passenger cars, trucks and spare parts have been lifted by Argentina. Trucks are given preference under the new regulations, which call for an exchange rate of 422.89 pesos per $100 compared to the old rate of 455. Passenger cars, formerly granted a rate of 455 pesos per $100, now will pay 485, while the exchange for spare parts remains unchanged at 455 pesos per $100.

Alclad Trademark Released

Aluminum Co. of America has released its exclusive rights to the registered trademark Alclad to the entire aluminum industry in order to simplify the identification of similar duplex material produced by manufacturers for the Government.

Perfect Circle Expands

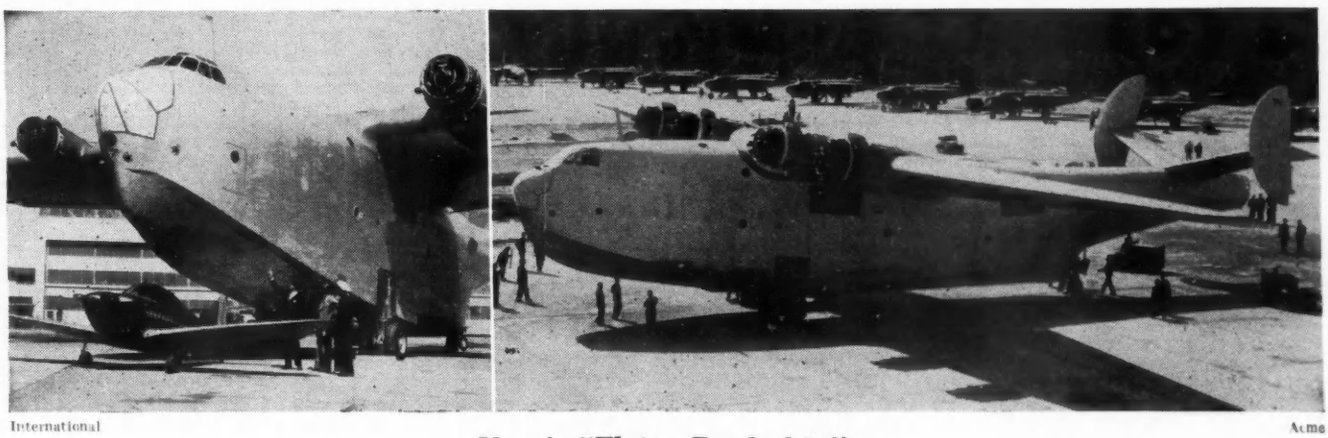
Perfect Circle Co. announces completion of new additions to its New Castle and Hagerstown, Ind., plants. Increased piston ring sales necessitated the construction.

Arms Contracts

(*Continued from page* 43)

Milwaukee, has had $12,500,000 allocated for the production of superchargers for high altitude bombers.

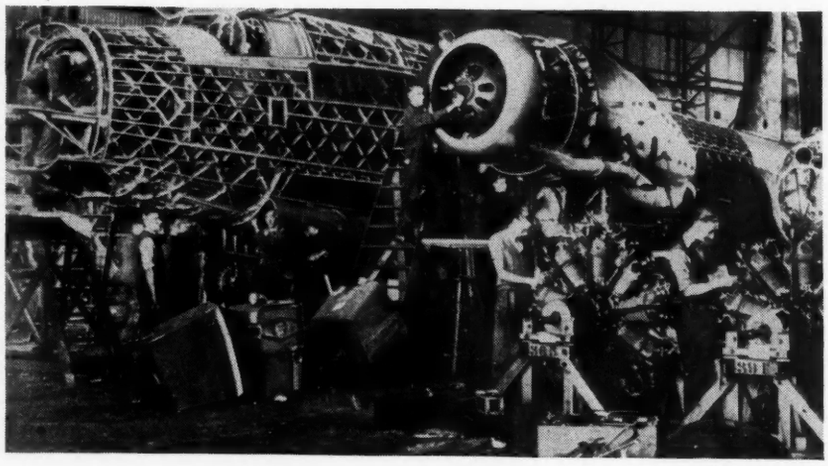
Recent national defense orders include $38,517,499 to Yellow Truck & Coach Mfg. Co., for 2½-ton cargo and tank trucks; $1,760,350 to Ford Motor Co., for 1½-ton trucks, tractor-trucks and chassis; $2,952,798 to Kelsey-Hayes Wheel Co., for machine guns; $6,183,956 to Diamond T Motor Car Co., for 4-ton trucks and wreckers; $293,798 to Continental Motors Corp., for flywheel assemblies; $312,000 to Chrysler Corp., for shells; $453,900 to Autocar Co., for 4 and 5-ton trucks; $1,496,073 to Delco-Remy Division of GM, for generator assemblies; $706,984 to Electric Storage Battery Co., for aircraft batteries; $199,476 to International Harvester Export Co., for air corps fuel trucks; $180,781 to Four-Wheel Auto Co., for tractors; $356,735 to Motor-Meter Gage and Equipment Division of Electric Auto Lite Co., for gages, and $108,739 to Mack Mfg. Corp. for spare parts.



International Acme

Navy's "Flying Battleship"

Uncle Sam's latest model warplane to make its appearance is this Navy patrol bomber XPB2M-1, the world's largest flying boat. This 70-ton sky giant has a wing spread of 200 ft., a hull length of 117 ft., and is powered by four 2000 hp. engines. For size comparison, a Culver Cadet plane was placed in the foreground. The Navy bomber is shown here as it was being rolled to a larger hangar at the Baltimore plant of Glenn L. Martin Co. to undergo preparations for its initial flight. A similar 125-ton warplane is said to be in the design stage.



British Combine

Wellingtons Never Die

Wellington bombers damaged by enemy action or by forced landings are never entirely lost. Battle-scarred warriors are flown to repair depots, where they are examined, overhauled or stripped. Damaged parts are replaced, the machines tested and then returned to active duty in five days. When the damage is too severe, they are dismantled, usable parts being saved and the rest is remelted to provide material for new Wellingtons. This photo shows part of a Wellington repair depot

PUBLICATIONS

The September issue of **Lubrication,** published by The Texas Co., contains an article on aircraft engine lubrication and a fuels and lubricants chart for aircraft engines.*

Lindberg Engineering Co.'s new booklet, **Furnaces for Armament,** describes and illustrates its various Cyclone furnaces.*

The Sept. issue of **Defense Data from The Houghton Line** contains an article on leather packings for aircraft and one on aircraft cylinder head castings.*

New bulletins by Ampco Metal, Inc., are **Ampco Metal in Aircraft,** which discusses the growing use of aluminum bronze by the aviation industry, and **Ampco Metal in Acid Resistant Service,** which describes the ability of Ampco Metal to resist acid and corrosion.*

Book No. 1874, a new catalog and data book on its **P.I.V. Gear variable speed transmission,** has been announced by Link-Belt Co.*

Thomson-Gibb Electric Welding Co.'s October issue of **Flashes** describes a new development of the Thomson Research Laboratory—**Resistance Welding Process.***

New literature by Westinghouse Elec. & Mfg. Co. as follows: book describing **plant distribution system** for use in industrial plants, power stations, etc.; bulletin on **Hipersil transformers;** leaflet describing **multi-pole contactors,** for use on machine tools and controllers as relays in control circuits, etc., and a leaflet describing edge wound resistors for starting and speed regulating duty in wound-rotor induction motors.*

Hoke and USA precision gage blocks are described and illustrated in an attractive catalog issued by the Pratt & Whitney Division of Niles-Bement-Pond Co.*

Motor Generator Corp. has published a pamphlet describing its latest models of **motor generator sets, electroplating and anodizing sets.***

A revised handbook of **welding electrodes and accessories** has been published by Hobart Bros.*

New literature by Westinghouse Electric & Mfg. Co. includes a leaflet describing **Pocket-Sized Vibrometers** and booklet on **materials handling equipment.***

Imperial Brass Mfg. Co. has announced a new catalog, giving complete information on **brass fittings, flexible fuel lines, shut-off and drain cocks, tube working tools,** etc.*

*Obtainable through editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia. Please give date of issue in which literature was listed.

Truck Production by Capacity

(U. S. and Canada)

	FIRST EIGHT MONTHS		
	Units		Per Cent of Total
	1941	1940	1941
1½ Tons and less	707,554	493,103	82.24
2 to 3 Tons	107,922	35,882	12.54
3½ Tons and over	17,986	10,320	2.09
Special and Buses	11,279	5,187	1.32
Station Wagons	15,612	10,770	1.81
Total	860,353	555,262	100.00

Investigate Icing

Through the use of elaborate equipment designed to simulate actual flying conditions, the National Bureau of Standards at Washington is trying to find a solution to the problem of engine intake icing, a flying hazard responsible for many crashes. Sponsored by the Army, Navy, the National Advisory Committee for Aeronautics and the Civil Aeronautics, the undertaking thus far has produced photographs of icing conditions which are said to startle even experts who have had long experience with the problem.

Bell Aircraft Tripling Niagara Falls Plant Size

Construction of an addition to the new Niagara Falls plant of the Bell Aircraft Corp. now under way will more than triple the size of the present factory. The Government bought the present Niagara Falls plant, whose construction had been financed by Bell. The Government in turn will lease the plant to Bell, plus the new addition, which it is financing from the start. The program is costing the Government $8,456,175. The addition is expected to be completed by spring.

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE INDUSTRIES

Continuing approximate stability of general business activity is indicated. The seasonally adjusted index of The New York *Times* for the week ended Sept. 27 declined one fractional point to 128.2 per cent of the estimated normal, as compared with 111.7 a year ago. The unadjusted index of *The Journal of Commerce* for the same period rose to 127.3 per cent of the 1927-29 average from 126.5 for the third week of the month.

Contracts awarded for heavy construction during the week ended Oct. 2 were 18 per cent above the corresponding amount last year, reflecting an advance of 84 per cent in Federal activity partly offset by recession in other fields, according to *Engineering News-Record.*

Department store sales during the week ended Sept. 27, according to the Federal Reserve compilation, were 24 per cent above the comparable total last year, as against a similar gain of 12 per cent for the preceding week and 17 per cent for the current year to date.

Railway freight loadings in the same period totaled 919,510 cars, the largest weekly number since 1930 and 12 per cent above the comparable figure last year.

The number of business failures during the week ended Oct. 2 was 172, as compared with 181 for the week before and 252 a year ago, according to the Dun & Bradstreet report.

Electric power production in the fourth week of September was 14.8 per cent greater than the output a year ago, as against a similar advance of 16.7 per cent a week earlier.

Crude oil production during the same period averaged 4,060,000 barrels daily, 14,200 barrels less than the average for the preceding week but 100,000 barrels more than the currently required output as computed by the Bureau of Mines.

Average daily output of bituminous coal in the week ended Sept. 27 was 1,783,000 tons, as compared with 1,655,000 tons in the week before and 1,692,000 tons a year ago.

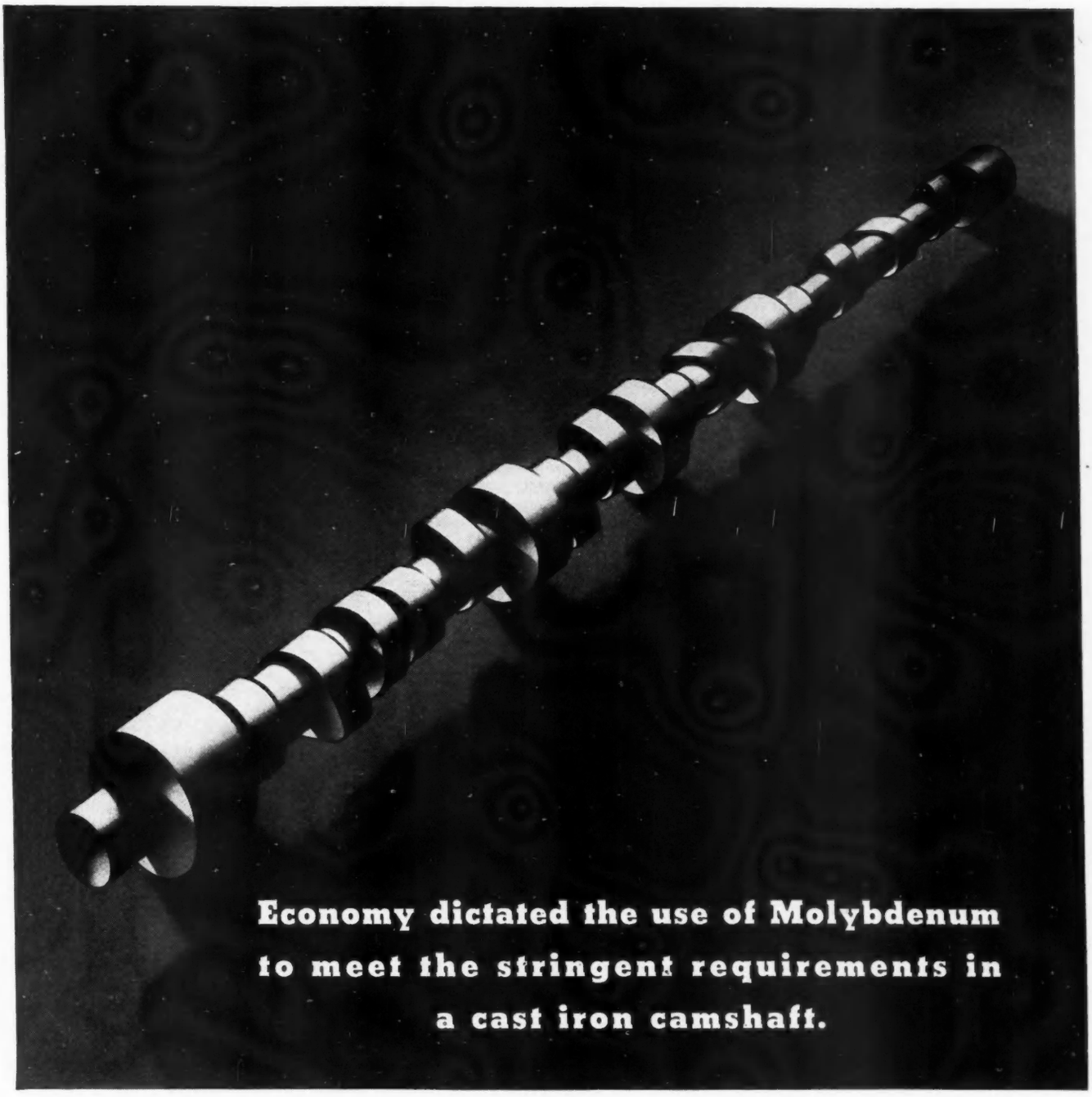
Cotton mill activity advanced more than seasonally in the same period. The New York *Times* adjusted index was 168.6 per cent of the estimated normal, as against 167.8 for the preceding week and 121.8 a year ago.

Professor Fisher's index of wholesale commodity prices for the week ended Oct. 3 rose one fractional point to 98.8 per cent of the 1926 average.

Member bank reserve balances decreased $33 millions during the week ended Oct. 1. Business loans of reporting members increased $58 millions and stood on that date $1817 millions above the total a year earlier.

San Francisco Auto Show

San Francisco will be one of the few major cities in the United States to hold an automobile show this year, the final decision to have a fall showing of the 1942 model cars having been reached at a conference of automobile dealer association executives. It will be staged at the San Francisco Civic Auditorium Oct. 18 to 26. Jack French, Dodge and Plymouth distributor, is Show Chairman.



Economy dictated the use of Molybdenum to meet the stringent requirements in a cast iron camshaft.

The automotive industry requires certain minimum physicals, plus wear resistant properties, to make practical a cast iron camshaft. Machinability also, of course, is a factor.

The Chromium-Molybdenum-Nickel (0.40-0.60% Mo) iron which resulted from the search for the ideal, has an as cast tensile strength of 50,000 p.s.i., is rigid enough for the requirements and tough enough to stand up under the operating conditions.

The analysis of the iron makes possible economical, efficient flame hardening of the cams, with a good, strong case to core bond.

Ask for our free technical book, "Molybdenum in Cast Iron", giving full practical data.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS. MOLYBDIC OXIDE BRIQUETTES FOR THE CUPOLA—FERROMOLYBDENUM FOR THE LADLE

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY

Cars of 1942

(*Continued from page* 19)

lized" type are treated with a "shot" of aluminum in the ladle. And since aluminum is tight, it may be eliminated from steel practice for the duration.

This is really a serious prospect. In the first place, the styling of cars during the past few years has relied upon the ease with which front fenders could be stretched in keeping with the styling note. This is particularly true of most cars for '42. When you consider that some fenders — Buick is an excellent example—have local elongation of upwards of 50 per cent, you can appreciate the role of stabilized sheet metal.

If aluminum is restricted and if the press shops have to fall back on the conventional sheet steels, either styling or press practice or both must needs retrogress about seven years or more. If the huge, one-piece front fenders are retained, it will be necessary to make them in two or three pieces and then to butt weld them together. The only other alternative is to change design to something compatible with the drawing properties of the available metal—and that would mean a complete reorganization of design throughout the industry.

OPM will have to take into account that the '42 designs already have been translated in production; that the complete tool and die program already is in actual production use; that any radical change at this time would entail a new die and tool program; and would require the acquisition of a lot of new resistance welding machines.

Plastics

It is quite unfortunate that so much publicity has been given in recent months to role of plastics as a panacea for all materials needs. This does not mean to imply that plastics are not all that has been claimed for them. To the contrary, plastics are perhaps the most important materials we have today. The useful applications of plastics are legion. And we can visualize a widespread use of plastics after the emergency is over.

At the present writing, however, plastics have recognized characteristics which define their uses and their limitations. But that is not all. Seemingly people have not stopped to consider that the plastics producers have a certain limited capacity machine. It is more than adequate to handle peacetime requirements but not nearly enough to take care of defense work as well.

Even that is only part of the story. Further bar to their use is found in the restrictions on ingredients. For example, there is a shortage of canvas duck which is used for laminated plastics; there is a restriction on cotton linters, on acetone, anhydrous ammonia, chlorine, formaldehyde, methanol, phenol, polyvinyl chloride, and other ingredients related to plastics production.

At least five general types of plastics —and these add up to some of the most useful materials known — the urea-formaldehydes, phenol - formaldehydes, acrylics, polyvinyl chlorides, and cellulose nitrate — will be taken out of the picture of civilian use. However, there remain a goodly number of other types available for civilian purposes. The job of the chemists is to determine the types best suited to the individual needs.

Certain types of plastics are being employed for instrument panels, for interior treatment as in the case of Chrysler Corp. cars, Packard, and others. Chrysler is relying upon plastics for glove compartment doors, for the new directional signal box to replace the zinc die casting, for the large oil pan seal, to replace aluminum. In this case, the plastic molding will have steel inserts. In addition, Chrysler has done a great deal of work with plastic hardware items such as door handles. The latest experimental development is an all-plastic door handle with a steel insert but it has not been reduced to practice at this writing.

Miscellaneous

Rubber represents a serious problem with no substitutes in prospect so far as tires are concerned. However, the manufacture of white side-wall tires has been stopped, producing a saving of about two pounds per tire. Doubtless only one spare will be permitted per car, eliminating the six-wheel models which are outmoded anyway.

For the past year the industry has looked to the development of the synthetic rubber-replacing materials for many special purposes. But Neoprene and other types have been ear-marked for the defense program. This is working considerable hardship but the difficulty is not insuperable. For instance a large number of motor car builders have been using the sealed, oiled-for-life, water pumps. If the small amount of Neoprene required for the seals is not available, the only recourse is to design entirely new types of pumps. Some producers already are taking steps to replace the synthetic rubber fuel lines with flexible steel hose.

Cork has been earmarked for defense or at least it is becoming quite scarce. At Chrysler, cork gaskets of various kinds are being replaced with synthetic rubber of the type available at the moment. In other cases, as at Olds, standard gasket materials are being substituted for cork.

Due to the difficulty in getting bronze bushings, Chrysler has adopted a new type of Oilite bushing with a steel back.

High strength cast irons used in cylinder blocks, formerly treated with alloying ingredients such as nickel and chromium and other additions, now are being made with additions of copper.

A recent report from Campbell-Wyant-Cannon Foundry indicates that this important supplier of quality cast iron and alloy iron parts has done considerable experimental work in the replacement of nickel. On camshafts which are used in most passenger cars, the 0.20 to 0.40 nickel content has been replaced by 0.50 to 0.75 copper, retaining the high chromium and moly content. This new alloy is said to have properties comparable if not superior to the former practice, and it will be introduced generally when the nickel supply runs out.

The same organization reports that it has employed copper for cylinder block castings for some years and is thoroughly sold on the quality of castings made with this ingredient. The report concludes with the statement that metallurgists, doubtless, will develop many new alloy formulas which may be superior to current practice, if and when the need for this is dictated by a shortage of the commonly used alloying ingredients.

Another major development is the addition of Grainal to cast iron. This is said to produce the desired surface hardness without variation, and to provide excellent machinability at these hardnesses.

The clutch disc used in the Olds and Cadillac Hydra-Matic transmission formerly were made of high grade bronze rolled stock. Now they are being made by Moraine with the powdered metal technique.

Structural Steels

We have left for the very last, the discussion of structural steels which represent so large a volume of the materials used in motor car construction. The major problem has been resolved into a rather practical and effective solution.

When nickel was placed under priority early this year, there was considerable hue and cry on the part of many people. It was not realized then that nickel steels had been finding their widest expression in heavy duty vehicles such as motor trucks and buses and tractors, diesel engines and heavy-duty engines, and in the aircraft field. True a lot of nickel has been used in motor car construction. But, on the other hand, some producers had been doing without it for a long time.

At any rate with nickel and chromium and vanadium and other high grade alloying materials ear-marked for defense, what can the industry do if it is to continue building long-lived, high performance automobiles.

Well, one answer is found in the Amola steels pioneered by Chrysler Corp. Amola steels have really come to the fore in recent years. At Chrysler, these steels have been adopted for all gears, axle shafts, drop forgings, and for intake valves. Unquestionably independent producers among parts makers and car builders will turn to Amola steels. We know that Studebaker already has done so.

Another answer is found in Buick practice. For over ten years Buick's metallurgists have been working with high manganese steels of the SAE 1300 series, containing from 1.60 to 1.90 manganese. As a matter of fact, the Buick cars built during the past few years have employed such steels for all of the major parts of the car.

If there is any pinch on manganese, such steels can be used right down to a manganese content of 1 per cent.

More recently, Buick has done considerable work on a further improvement of manganese steels—improving hardenability and machinability—with special "sweetening" ingredients such as the Grainal treatment recently announced by Vanadium Corp. It takes only four pounds of Grainal per ton of steel to produce the remarkable results experienced by Buick.

Following Buick's lead, other General Motors units have found it expedient to adopt these high manganese alloys. Olds is one example. Too, Olds has found it possible to replace the nickel steel connecting rod bolts with SAE 1335 high manganese steel, the same as is being used for gear steel. Other producers have preferred to retain the high strength nickel alloy bolts in the hope that the relatively small amount of nickel thus required may be made available.

Future Prospects

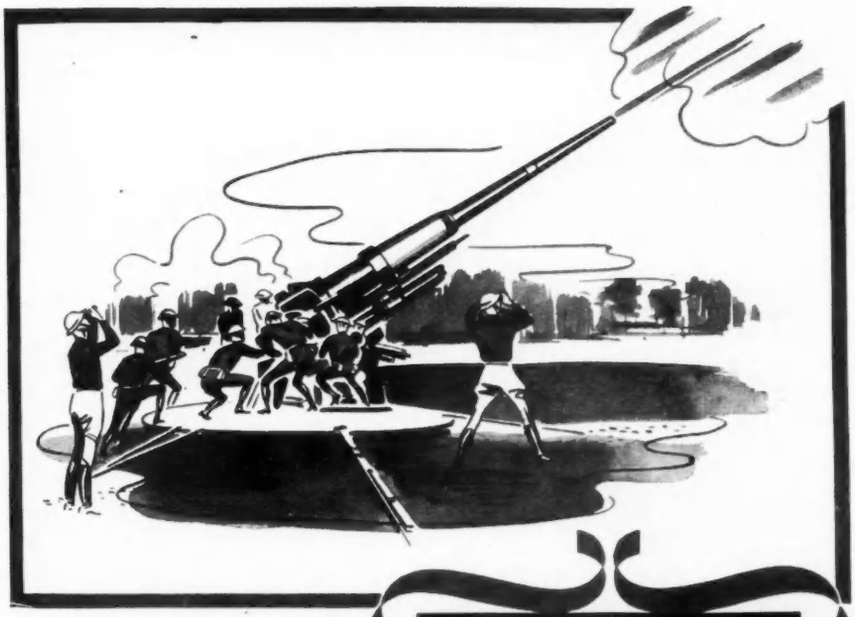
It has been aptly said that every cloud has a silver lining. And we profess to see a bright picture for the future based on the activity stemming from the national defense.

Consider the tremendous expansion of facilities for the production of aluminum and magnesium. When the emergency is over—and we fervently hope that there will be a peace again—there will be an era of development unheard of in the past, in the expansion of uses of these valuable structural alloys. While it is too early to visualize these applications, it is certain that engineering brains will find many ways in which aluminum and magnesium will fit into the motor car picture, and for that matter into the heavy duty field to improve performance and to greatly reduce weight.

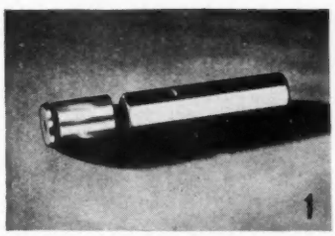
Zinc alloy die castings have a major role in automotive design and construction due to the manifold advantages of the die casting technique. The industry will find many new applications and will be glad to return to some of the applications that had to be abandoned.

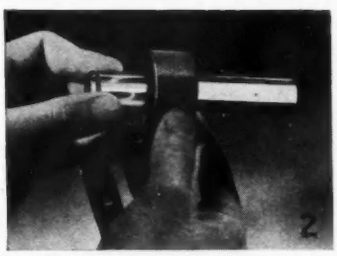
Plastics will have grown to new stature after the emergency. Greater molding facilities, more useful types, these and other considerations will give free play to the talents of industrial designers. Owing to the characteristic determination and technical skills of the Ford organization, we may even approach the goal of a plastic motor car or at least one with many large plastic sections.

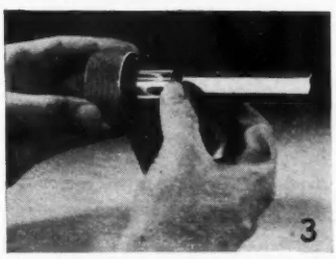
Yes, the future holds great promise—after the emergency—for those who carry on.

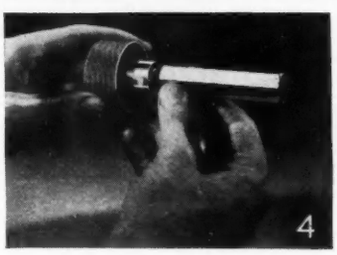


A DIRECT HIT *Every Time*









Did you ever try to put an ordinary plug gage in a hole that was just one ten thousandth inch larger in diameter? It can be done, of course, but it seldom is the first time.

Pictured below is a Sheffield Guidegage and an ordinary ring gage one "tenth" larger in diameter. One hundred men were asked to slip the ordinary rear end of the plug gage into the ring as in Fig. 2. Only two were able to do it the first time, five on the second trial and 54 required more than ten trials.

Then, each of these men were asked to insert the forward end of the Sheffield Guidegage as in Fig. 3. Every one succeeded the first time. Why? Because of the guiding disc and annular groove which forces the gage to center itself. No skill is needed whatever.

This Guidegage principle is especially advantageous in checking work that must be gaged in an awkward position or while still in the machine, and work which must be held to very close tolerances.

The principle of the Guidegage prevents undue wear and damage to the forward end of the gage, and saves a very considerable amount of time in the gaging operation.

Write for information

★★★ SHEFFIELD ★★★

GAGE CORPORATION • DAYTON, OHIO, U.S.A.

MASTER GAGEMAKERS

MEN and MACHINES

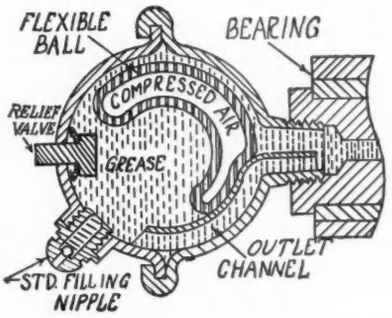
(*Continued from page* 41)

Studebaker Machine Co. Announces Hydraulic Vise

Studebaker Machine Co., Chicago, Ill., is offering a hydraulic vise for which it is claimed that it will save time and effort. It is capable of developing a pressure of up to 5 tons between the jaws and will speed up small press and cutting operations, as well as ordinary vise work. The new vise is controlled entirely by the workman's foot, leaving both hands free for setting up or removing the work.

Simplex Mfg. Co. Improves Grease Cup

Important improvements in its 5000-mile grease cup for spindles, shackles, etc., has been announced by the Simplex Mfg. Co. of Detroit, Mich. It is claimed that by incorporating a simple relief valve it is now possible to see when the reservoir is full and impossible to blow it up by the use of the most powerful pressure grease gun; they also claim that an improvement in the neoprene ball makes possible the continuous lubrication of loose or worn bearings.



Simplex Grease Cup

Improved Spark Plug

Patents on a new five-ribbed insulator have just been issued to the Champion Spark Plug Co. The new design helps prevent a surface accumulation of dirt that may serve as a bridge for shortening the spark

Burgess Vibro-Tool Has Variety of Uses

A new versatile tool operating on the vibrating principle is announced by *Burgess Handicraft*, division of Burgess Battery Co., Chicago. The tool makes 7200 strokes per minute, the stroke being adjustable up to ⅛ in. Its chuck will grip a large variety of engraving needles, cutting knives, gages, and hammers. Special fittings such as depth gages, etc., enhance its utility in both craft work and production. The Burgess Vibro-tool can be used for engraving, cutting, hammering, or carving, on metal, wood, linoleum, sheet rubber, sheet cork, glass, ceramics and most other materials. It can be used with jigs, or fixtures, to cut or engrave to a template.

Landis Nib, Norton Nib, Cincinnati Nib for truing and shaping emery wheels

Shaped Diamond Cutting Tools for turning, boring, facing

DIAMONDS STAY ON THE JOB LONGER!

Want to reduce your "time-outs" for tool sharpening and re-tooling? Set up your turning, boring, milling and truing machines with "Asco" Diamond Tools. Diamonds—the hardest substance known—permit precision cutting at higher speeds—and stay on the job longer. "Asco" Diamond Tools cut to closer tolerances and produce a smooth finish that often eliminates subsequent grinding and polishing.

Be sure to specify "Asco" on all Diamond Tools and get full benefit of Anton Smit & Company's more than 30 years' specialization in industrial diamonds. Large stocks of Bortz, Carbons, Ballas, Cleaved or Natural Points, Crushing Boart, Splint and Powder are always on hand for immediate delivery. Send blueprints of special shaped tools for quotation. Write for illustrated folder and prices.

IMMEDIATE DELIVERY ON ALL DIAMOND TOOLS AND RE-SETTING

DRESSING TOOLS • SHAPED TOOLS • DRAWING DIES • CORE BITS • PHONO POINTS • ETC.

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IMPORTERS OF INDUSTRIAL DIAMONDS—BORTZ, CARBONS AND BALLAS.
MANUFACTURERS OF ALL KINDS OF DIAMOND TOOLS.

Tinnerman's New Speed Nut Design

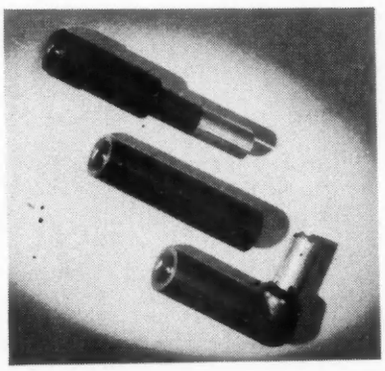
New flat-anchor type Speed Nuts were announced recently for blind-mounting and flush blind-mounting assemblies. They are designed with a ball formation surrounding the prongs that is sufficient to span the standard dimpling for countersunk flat-head screws

Anchor-type Speed Nuts for aircraft applications

or bolts. The illustration shows a countersunk flat-head screw engagement with Speed Nut riveted in position. These aircraft Speed Nuts are made of special molybdenum aircraft spring steel and are said to have remained tight under severe vibration tests. The advantages claimed are an 80 per cent saving in weight, speedier application, and drastic cost reduction. The manufacturer is Tinnerman Products, Inc., Cleveland, Ohio.

Erie Company Develops Suppressors for Engines

The accompanying photograph shows a group of "suppressors" manufactured by Erie Resistor Corporation, Erie, Pa. These units, which are installed on the distributor or spark plugs of automotive engines, consist of a carbon-resistance element which dampens or cuts down the amplitude of the high-frequency portion of a spark plug discharge without seriously reducing the energy of the low-frequency portion which is necessary for proper ignition. Erie suppressors are said to accomplish this efficiently because their resistance remains substantially constant during the entire firing period. Because of this desirable characteristic, they can be made with a comparatively low resistance value that does not increase gasoline consumption or result in loss of motor power. These suppressors are also being manufactured in London and we understand that they are being used in large numbers on British combat units.



Erie Suppressors

New Potentiometer and "Watchman's Protector"

Rowe Radio Research Laboratory Co., Chicago, has developed an angular sweep potentiometer for use with oscillographs. It permits correlation of the angular position of any shaft connected to it, with the beam position of the oscillograph. Any type or make of oscillograph may be employed to obtain this angular sweep. Shaft speeds up to 20,000 r.p.m. are said to be permissible and the static calibration is said to hold up to the highest speeds.

A new alarm system, known as the "Watchman's Protector" also is announced by the Rowe company. The watchman or guard carries a small device called "the walking stick." In the event of trouble, encountering a suspicious person, or persons, or upon being attacked, the pushing of a small button on the walking-stick handle automatically sends a special "key" radio signal which in turn operates an alarm. This will set off bells, sirens, etc., or privately warn other guards, police, or a detective agency.

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FACTS

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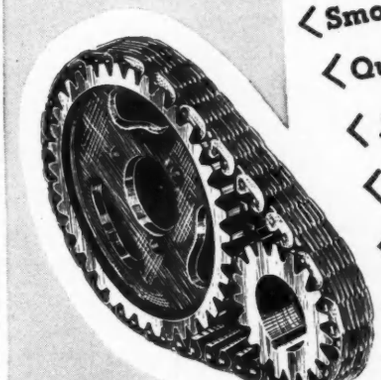

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DIVISION OF BORG-WARNER

MORSE
SILENT TIMING CHAINS

National Metal Congress

(*Continued from page* 35)

dale, National Association of Manufacturers, will speak for industry; Rear Admiral Wm. H. Blandy, chief, Bureau of Ordnance, U.S.N., for the Navy, and Brigadier General Schulz, director of purchases, U. S. Army, for the Army. Under Secretary of War, Robert A. Patterson, will represent the War Department.

The annual fall meeting of the two metals divisions of the American Institute of Mining and Metallurgical Engineers, during the first three days of the Congress will feature joint and simultaneous sessions, committee meetings and a round-table discussion on "Order-Disorder Phenomena." Headquarters for the institute will be at the Ritz-Carlton Hotel.

Approximately 60 papers are tentatively scheduled for presentation by the American Welding Society in its general sessions and in its industrial and fundamental research groups. Headquarters for the AWS will be at the Bellevue-Stratford Hotel.

The welding industry will be represented at the metal show by all types of welding. Included in this group are electrodes and electric controllers as well as various grades of welding wire for gas and electric welding.

Heat treating furnaces will be on display, comprising salt bath, annealing-electric, gas and oil fired, induction, and atmospheric controlled furnaces of all types and sizes. In addition there will be furnaces and heating equipment for heating rivets and bars, industrial oil heating apparatus and various insulating materials for furnaces and electric heating elements.

In the steel and non-ferrous fields, visitors will have the opportunity to see the various alloys in the finished form and also through products made from them.

Testing equipment to indicate hardness, tensile, torsional strength, fatigue and many other properties of metals will be demonstrated. Temperature recording and control equipment will include devices for indicating, recording and controlling temperatures. Tools of all types will be on exhibit, including hack saws and files, electric drills, diamond tools, tungsten carbide cutters, diamond test cutters and reamers. Included in this group are abrasive cutting machines and abrasive wheels.

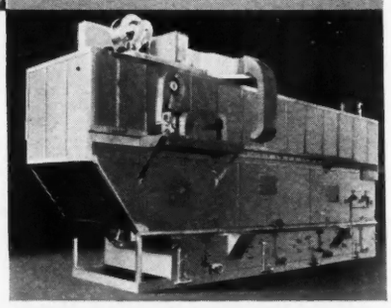
Plating processes and materials to be shown include plating equipment generators, plating barrels, polishing lathes, induction heating and hardening equipment and methods. Methods in castings will be illustrated, dealing with malleable treated and heat corrosion resistant items.

There will be hundreds of other aids to better production. They include heat treating salts, carburizing salts, compounds and supplies. Noble metals will be shown in new uses. Handling equipment such as cranes, trucks and hoists are included. Pieces of various optical measuring, metallographic and spectrographic equipment, blue printing machinery and drafting room equipment are to be exhibited. Laboratory equipment includes polishing machines, chemical determinators and other items for chemistry laboratory work. Hard surfacing alloys for various parts of industrial machinery will be on display.

Petroleum products, quenching oils, rust preventatives and metal cleaning compounds will be shown. Sand blast equipment and detergents will be on display. Industrial appliances will include safety shoes, masks, goggles and other safety equipment as well as water dispensing equipment. X-ray equipment, turbo compressors and metal cloth are included in the miscellaneous classifications.

Trade and business publications in the metals and associated fields have made arrangements to provide various informational services at their exhibit booths. Grade and professional associations, allied with the metals field, will be represented by exhibit booths.

Efficient Cleaning Of ALL Metal Parts

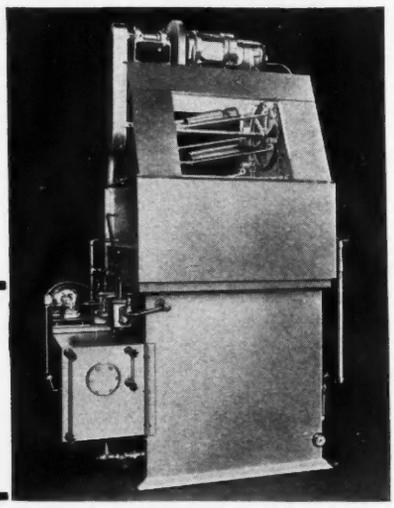


DETREX Degreasers and Washers are engineered to meet specific metal cleaning requirements. Equipment is designed to handle parts of every size and description.

For example, if the cleaning is to be done between production operations, prior to plating or in preparation for inspection, the machines are built to be efficient units of the departments in which they are used.

If your production—like that of hundreds of other plants—is turning rapidly to the manufacture of armament parts, you are undoubtedly faced with many new metal cleaning problems. The answer to them can always be found in the use of Detrex products—Degreasers using stabilized safety solvents Perm-A-Clor and Triad . . . Detrex machines for Alkali, Spirits and Emulsion Cleaning . . . and Triad alkali compounds, strippers and emulsion cleaners.

Write for literature or free engineering consultation.



● Above: Detrex processing machine incorporating alkali wash, chromic acid dip, hot water rinse and overhead drying oven.

● Right: Special design spray type Detrex Degreaser — for the production cleaning of shells.

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